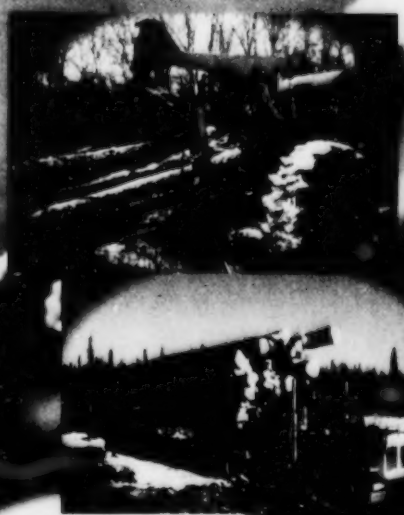
Selecting wildlife species for integrating habitat supply models into forest management planning in Manitoba

D.H. Kuhnke and W. Watkins

Northern Forestry Centre
Information Report NOR-X-357



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D.H. Kuhnke and W. Watkins[1]

INFORMATION REPORT NOR-X-357

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ABSTRACT

In selecting wildlife species for integrating habitat supply models into forest management planning in Manitoba, the underlying principle is that the habitat requirements of most species found in the boreal forest will be satisfied if habitats are maintained for a carefully selected mix of species. The selection methods and 13 basic steps used by the Manitoba Forestry/Wildlife Management Project to arrive at 19 species of wildlife are described. The provincial forest inventory was used as the basis for identification of major habitat types. Emphasis was placed on species for which habitat suitability index models were developed elsewhere in North America, and on ensuring that all the major habitat types have at least one species that is dependent on it for its life requisites.

RÉSUMÉ

Le choix d'espèces fauniques pour l'intégration de modèles de la disponibilité d'habitats à la planification de l'aménagement forestier au Manitoba repose sur le principe suivant : les besoins en habitat de la plupart des espèces de la forêt boréale seront satisfaits si l'on conserve les habitats propices à un assemblage bien précis d'espèces. Les auteurs décrivent les méthodes de sélection employées par les responsables du projet de gestion de la faune du service des forêts du Manitoba et les 13 étapes de base qu'ils ont suivies pour choisir 19 espèces fauniques. La détermination des principaux types d'habitat était basée sur les données de l'inventaire forestier provincial. Les responsables des travaux se sont intéressés surtout aux espèces pour lesquelles on avait déjà élaboré des modèles d'indices de convenance d'habitats ailleurs en Amérique du Nord et se sont assurés que chaque type d'habitat principal accueille au moins une espèce qui en dépend pour satisfaire ses besoins biologiques.

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INTRODUCTION

Sustainable development may be thought of as the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity. This approach allows the land base to maintain its potential to meet the needs and aspirations of present and future generations (Canadian Biodiversity Strategy 1995).

The components of biological diversity include ecosystem, species and genetic diversity. From a practical forestry perspective, sustainable development refers to forest management that does not jeopardize the future of the benefits and values that forests provide, such as wildlife and fish habitat, watershed regulation and recreational opportunities.

Forest management practices have an affect on many of the components of biological diversity. Logging, for example, can directly affect the species diversity of trees in a given area. The large spatial scale of forest management operations, and the manner in which large volumes of timber have been harvested, has driven the concern Canadians have expressed about the condition of the nation's forests. Wildlife is a component of biological diversity, and its conservation has emerged as a specific issue.

Forest managers have become sensitive to the values Canadians place on wildlife and are attempting to incorporate the needs of wildlife into forest management planning. To ensure that adequate habitats are supplied over time and space so that healthy wildlife populations may flourish, managers need the means to relate the habitat needs of wildlife to the land base.

The Manitoba Forestry/Wildlife Management Project (MFWMP) is a partnership of provincial, federal, and private forestry and wildlife management agencies charged with developing models capable of predicting the impact of forest management practices on the supply and quality of habitats for resident wildlife. There are more than 200 vertebrate species that live in Manitoba's boreal forest, however, and developing models for each of these species would be a daunting task beyond the collective resources available to the MFWMP's participants, and is impractical from a management perspective. This report describes the selection methods and procedures used by the MFWMP to arrive at 19 vertebrate wildlife species, that use most of the major habitat types found in the boreal forest, that can be used as guides to forest management planning.

RELATING WILDLIFE HABITAT NEEDS TO THE FOREST LAND BASE–WILDLIFE HABITAT SUITABILITY MODELS

The boreal forest, the largest forest region in Canada, is a mosaic of plant communities that are constantly changing because of natural or human-induced factors. Each plant community offers differing attractions to people and wildlife at any particular time, and favors certain wildlife species while providing little benefit to others. Within each plant community, an associated community of animal species thrives, obtaining habitat including food, shelter, and space to live. Suitable habitat is the fundamental prerequisite for the existence of wildlife (McCullough 1994).

Habitat information about wildlife species is frequently represented by scattered data sets collected during different years and seasons and from various sites throughout the range of a species (Allen et al. 1987). Knowledge about the habitat needs and preferences of wildlife species, therefore, is often based as much on the personal knowledge and intuition of local experts as it is on actual data (Allen et al. 1987).

The U.S. Fish and Wildlife Service has developed a modeling process, the American Habitat Evaluation Process, used widely across North America to formally synthesize habitat use information from species experts and studies. The models developed by this process are termed Habitat Suitability Index (HSI) models. The HSI models combine many separate physical and biological factors into one quantitative index of habitat quality for a given species on a given landscape (Hanley 1994).

THE LAND BASE—MANITOBA'S BOREAL FOREST

Manitoba has five ecozones (Fig. 1). These broad geographic mapping units provide a basis for national perspectives and comparisons of differences in geography (substrate structure, macroclimate, soil zones, and plant formations). The ecozones that are germane to the MFWMP are the Boreal Shield and Boreal Plains. They contain most of the boreal forests in the province, and are the ecozones where most forest management occurs.

The best source of information on the trees of the boreal forest across both ecozones is the Manitoba Forest Resource Inventory (FRI) that is developed and maintained by the Manitoba Department of Natural Resources. The FRI provides information on commercial and non-commercial forest land.

The many types of stands present within the commercial forest are described by a five-digit stand aggregate. Each digit in the stand aggregate denotes one type of characteristic of a forest stand, while the range of values for each digit describes the nature of the characteristic. An example of a stand aggregate is shown in Table 1: all possible components of a stand aggregate are shown in Appendix 1.

The stand aggregate is, however, difficult to relate to wildlife habitats because of the high number of unique stand aggregates and the constant need to interpret each one. What was needed was a simpler, more condensed way to describe the full spectrum of boreal forest habitats.



Figure 1. Manitoba's ecozones (Ecological Stratification Working Group 1995).

CONDENSING THE FOREST RESOURCE INVENTORY

Of the main components of the FRI, those that are thought to influence the selection of forest stands by various wildlife species are stand maturity, cover type (e.g., conifer-dominated mixedwoods), and species composition.

Stand maturity is generally synonymous with successional stage, expressed by four classes within the FRI: regeneration (usually recently disturbed sites of seedlings and other vegetation like grasses and shrubs), juvenile (stands of saplings or pole-sized trees), intermediate (stands of vigorously growing trees), and mature/overmature (stands of trees with a declining rate of growth or with trees nearing the end of their life cycle). Stand maturity may also be viewed as a surrogate for tree height. An examination of the various combinations of cover type and tree species composition that make up the subtypes within the FRI suggests that six new cover types can summarize all combinations of cover type and species composition.

Table 1. A sample stand aggregate, 50133, in the Manitoba Forest Resource Inventory

Components of the stand aggregate	Explanation of stand aggregate components[a]
5	**Cover type**. There are 10 cover type classifications, 5 = softwood dominated mixedwoods.
0	**Subtype**. Species composition in broad groups within cover type. Cover type 5 has 8 subtypes, 50 = 51% or more white spruce by basal area, second major species is a hardwood. There are 70 subtypes among the 10 cover types.
1	**Site classification**. Moisture regime by land types and associated indicator plants. There are 6 moisture regimes.
3	**Cutting class**. Based on size, vigor, state of development, and maturity for harvesting purposes. There are 6 cutting classes, 3 = immature.
3	**Crown closure**. There are 4 classes of percent crown closure, 3 = 51–70%.

[a] A complete description of the components of the stand aggregate is presented in Appendix 1.

The combination of four successional stages and six new cover types constitutes 25 vegetative communities,[1] or habitat types, within the commercial forest.

The FRI also identifies five classes of lands that do not support commercial timber growth or do not support trees at all. These non-commercial and non-forested lands are, however, important components of the boreal forest ecosystem for wildlife, and they were therefore added to the list of 25 commercial forest habitat types.

The resulting 30 habitat types that characterize forest conditions within Manitoba's boreal forest are shown in Table 2. Condensing the FRI in this manner is similar to the approach used on the Weldwood Forest Management Agreement area in Alberta for their integrated forestry–wildlife program (*see* Bonar et al. 1990).

EMPHASIS SPECIES AND INDICATOR SPECIES

Emphasis species is a term widely used to label species that reflect society's commercial, recreational, cultural, and aesthetic values. Species that are harvested, either commercially or recreationally, are obvious examples. But many species have cultural and aesthetic values that are less tangible and vary widely between areas. The species selection process must reflect these societal values for the process to be acceptable to the various stakeholders who influence forest management decisions.

Indicator species, on the other hand, have narrower habitat requirements that can be used to indicate the relative suitability of habitat for other species that share a similar preference. For example, the marten (*Martes americana*) is primarily a denizen of mature or overmature forests dominated by spruce (*Picea* sp.). A precipitous decline of

[1] The grass–forbs cover type within the shrub–seedling successional stage brings the number of habitat types to one more than the expected 24 habitat types. This habitat type, usually the result of disturbance, precedes the eventual development of other habitat types.

Table 2. Habitat types condensed from the Manitoba Forest Resource Inventory

Habitat type	
Successional stage	Cover types
Non-commercial forest land[a]	Riparian
	Marsh–bog
	Treed muskeg
	Treed rock
	Willow–alder
Stands at shrub–seedling stage	Grass–forbs
	Hardwoods
	Mixed deciduous
	Mixed coniferous
	Softwood—spruce
	Softwood—jack pine
	Softwood—larch
Stands at pole–sapling stage	Hardwoods
	Mixed deciduous
	Mixed coniferous
	Softwood—spruce
	Softwood—jack pine
	Softwood—larch
Stands at intermediate stage	Hardwoods
	Mixed deciduous
	Mixed coniferous
	Softwood—spruce
	Softwood—jack pine
	Softwood—larch
Stands at mature to overmature stage	Hardwoods
	Mixed deciduous
	Mixed coniferous
	Softwood—spruce
	Softwood—jack pine
	Softwood—larch

[a] Not a successional stage in the usual sense.

this sort of habitat could mean not only a decline in marten populations but also the decline of populations of other species that inhabit mature spruce-dominated forests.

The MFWMP recognized that the species selection process must result in a combination of emphasis species and indicator species,[2] rather than only one or the other. Attention was also paid to the possibility that a species may fulfill a dual role as both an emphasis species and an indicator species.

There is a low probability that all the major habitat types will be used by emphasis species alone. It is essential that species be selected for all major habitat types so that the natural faunal assemblages found in the boreal forest can be maintained in the face of increasing demands for forest products and non-timber benefits. The selection of indicator species only, on the other hand, may ignore the values society places on certain species.

Selecting species for habitat management to ensure the sustainable use of forest resources requires an approach that incorporates economic and social, as well as ecological, concerns. Examples of this approach are becoming more common (Bonar et al. 1990; Saskatchewan Forest Habitat Project 1991).

RELATING WILDLIFE SPECIES TO HABITAT TYPES

Information about vertebrate species of wildlife was solicited from species authorities across the province who were asked to associate the life requisites (food, cover, reproduction) of particular species to the habitat types condensed from the FRI (Table 2). Two hundred and fifty-six vertebrate species found in the Boreal Shield and Boreal Plains ecozones were eventually categorized (Appendix 2). Of these, 158 species are common to both ecozones, 79 are unique to the Boreal Plains, and 19 are specific to the Boreal Shield (Appendix 3).

PRELIMINARY SCREENING OF SPECIES

The first step the MFWMP undertook was to eliminate those species that clearly were not suitable for forest habitat supply modeling. These included:

a) species that are aquatic, semi-aquatic, or not associated with forest lands;

b) species that are habitat generalists and do not represent particular forest types or age classes;

c) species that were introduced;

d) species whose population or range in the province is limited, or is a result of a recent or ongoing range extension, or those species that are infrequently found within either ecozone.

These criteria eliminated 119 species from further consideration. The remaining 137 species proceeded to the next step (Table 3). Several more species from this group of 137 were eliminated by the same criteria, but further on in the selection process, when the habitat requirements of these species had been examined more closely.

[2] The use of vertebrate species meant to indicate habitat quality and predict the effects of future impacts on habitat quality for other species is not without its criticisms as addressed by Landres et al. (1988) and others. Foremost among these is the use of a species to act as a surrogate for other species within the same guild, the use of indicators in multiple roles (i.e., species chosen to fulfill both emphasis and indicator roles) without research verifying the appropriateness of the species for each role. There are also problems associated with assuming the use of an indicator selected in another geographic area is appropriate for use in the area in question, and finally, various criteria used to select indicators for ecological assessments, such as species size, area requirement, and residency status, are not collectively addressed. Also, model validation and examination of extrinsic factors must be incorporated into the process of using indicators for predicting habitat quality.

The MFWMP addressed these concerns during the course of the species selection process. The use of guilds for indicator species selection was, for example, not considered because of problems associated with selecting indicator species based on guilds. The HSI models are to be calibrated for Manitoba conditions based on the expert opinion of resident wildlife authorities supported by local data, and validation exercises will be conducted for all HSI models.

Table 3. The 137 species resulting from an initial screening for HSI modeling suitability

Alder flycatcher
American crow
American kestrel
American redstart
American robin
American toad
American tree sparrow
Arctic shrew
Bald eagle
Barred owl
Bay-breasted warbler
Beaver
Belted kingfisher
Black-and-white warbler
Black bear
Black-backed woodpecker
Black-billed magpie
Black-capped chickadee
Black-crowned night heron
Blackpoll warbler
Black-throated green warbler
Blackburnian warbler
Blue jay
Blue-spotted salamander
Bonaparte's gull
Boreal chickadee
Boreal owl
Broad-winged hawk
Brown creeper
Bufflehead
Canada warbler
Canadian toad
Cape May warbler
Cedar waxwing
Chestnut-sided warbler
Chipping sparrow
Common goldeneye
Common merganser
Common nighthawk
Common raven
Common redpoll
Common yellowthroat
Connecticut warbler
Cooper's hawk
Cope's gray treefrog
Dark-eyed junco
Deer mouse
Downy woodpecker
Eastern kingbird
Eastern wood pewee
Elk
Evening grosbeak
Fisher
Fox sparrow
Golden-crowned kinglet
Golden-winged warbler
Gray jay
Gray treefrog
Great blue heron
Great crested flycatcher
Great gray owl
Great horned owl
Hairy woodpecker
Heather vole
Hermit thrush
Hooded merganser
Indigo bunting
Least flycatcher
Lincoln's sparrow
Little brown bat
Long-eared owl
Lynx
Magnolia warbler
Marten
Meadow vole
Mink
Moose
Mourning dove
Mourning warbler
Nashville warbler
Northern bog lemming
Northern flicker
Northern goshawk
Northern hawk-owl
Northern redbelly snake
Northern saw-whet owl
Northern spring peeper
Northern waterthrush
Olive-sided flycatcher
Orange-crowned warbler
Osprey
Ovenbird
Palm warbler
Philadelphia vireo
Pileated woodpecker
Pine grosbeak
Pine siskin
Porcupine
Purple finch
Pygmy shrew
Red crossbill
Red squirrel
Red-breasted nuthatch
Red-eyed vireo
Rose-breasted grosbeak
Ruby-crowned kinglet
Ruby-throated hummingbird
Ruffed grouse
Sharp-shinned hawk
Sharp-tailed grouse
Solitary vireo
Southern bog lemming
Southern red-backed vole
Spruce grouse
Swainson's thrush
Tennessee warbler
Three-toed woodpecker
Tree swallow
Veery
Western kingbird
Western wood pewee
Whip-poor-will
White-breasted nuthatch
White-tailed deer
White-throated sparrow
White-winged crossbill
Wilson's warbler
Winter wren
Wolf
Wolverine
Wood duck
Wood frog
Woodland caribou
Woodland jumping mouse
Yellow warbler
Yellow-bellied flycatcher
Yellow-bellied sapsucker

EVALUATING EMPHASIS SPECIES: THE MERIT EVALUATION INDEX

A number of systems have been developed by ecologists for evaluating or ranking potential emphasis species. Most use quantitative categorical data.

If the primary goal of management planning is preservation of biodiversity and the conservation of species vulnerable to human actions, the ranking systems are based primarily on variables such as population and range trends, sensitivity to disturbance, and life history. These types of systems have been used to highlight taxa with a high extinction risk (Mace and Lande 1991; Nature Conservancy 1982), to set wildlife conservation priorities (Thompson et al. 1993), and to focus land acquisition and habitat management efforts (Millsap et al. 1990).

However, if the primary goal is to integrate economic concerns or additional societal concerns into management planning, criteria such as the significance of sport or commercial harvest, or special aesthetic values, must also be incorporated into ranking systems. This often occurs in an informal way as regional resource managers set yearly budget priorities for public agencies.

After examining existing ranking systems, the MFWMP concluded that none completely met the needs of the project. The objective of the MFWMP in developing its own merit evaluation index was to provide a logical ranking of vertebrate species in Manitoba's boreal forests, maximizing the separation of species and avoiding double scoring, or using highly correlated variables.

At first, each category was modeled after components of existing indexes. The scores reflected those in the published literature. Then, members of the MFWMP tested the initial ranking system by randomly selecting and testing subgroups of species from the list of 137 species that resulted from the preliminary screening. Their rankings were evaluated for consistency and accuracy. Scores were modified where necessary to achieve a greater separation between species by an iterative process of scoring, evaluating, and re-scoring. The resulting ranking system was then presented to a larger group of government and industry biologists and resource managers for further review. Final modifications were made, based on their comments (Table 4).

The five merit categories of criteria used to rank the identified 137 species were

Status
Ecology
- Period of occurrence
- Population concentration
- Importance in system

Economic/Cultural Importance
- Furbearers
- Non-furbearers
- Cultural/aesthetic

Knowledge of Species
- Model development
- Monitoring
- Distribution

Sensitivity to impact

Status

The first merit category, Status, represents the degree of management concern that exists for a species. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and Manitoba Endangered Species lists provided the basis for scoring species in this category, with listed species receiving the highest scores. The COSEWIC's categories of endangerment have changed since emphasis species were selected by the MFWMP. Rare is no longer used as a category.

Vulnerability to extinction or extirpation is inversely related to population size. Species with low numbers of breeding adults are the most vulnerable. National and provincial lists of endangered species reflect a compilation of what is known about a species and how urgent is the need for management action at a given time.

Trends in population and range sizes were used as supplementary information to score species not officially listed, reflecting concern for any population that is declining, regardless of size. The scoring process differentiated between trends that were documented and those that were only surmised.

Ecology

The second category, Ecology, is composed of three subcategories that examine different facets of

Table 4. Merit categories, merit sub-categories, criteria, and scores used to rank terrestrial vertebrates in the Boreal Shield and Boreal Plains ecozones in Manitoba

Merit category	Merit sub-category	Criteria	Score[a]
Status		Listed as endangered by COSEWIC or Provincial Endangered Species Act	10
		Listed as threatened by COSEWIC or Provincial Endangered Species Act	9
		Listed as vulnerable by COSEWIC	8
		Listed as rare[b] by COSEWIC	7
		Recently downlisted by COSEWIC or Provincial Endangered Species Act	6
		Population or range known to be declining	5
		Trend in population or range unknown but suspected to be declining	4
		Population or range formerly declining but presently stable or increasing	3
		Population or range suspected to be stable	2
		Population or range suspected to be increasing	1
		Population or range known to be stable or increasing	0
			Max. points = 10
Ecology	Period of occurrence	Permanent resident	2
		Resident during portion of year only (usually breeding season)	1
		Transient or non-resident	0
	Population concentration	Individuals within populations congregate throughout the year (roosts, herds, etc.)	2
		Individuals within populations congregate seasonally (hibernacula, breeding sites, migration focal points, etc.)	1
		Individuals within populations do not congregate	0
	Importance in system	Species contributes directly to the physical maintenance of an ecological community (e.g., beaver)	3[c]
		Species contributes directly to creating or maintaining life requisites on a local scale for one or more other species (e.g., primary cavity excavators create cavities that are then used by other cavity nesters)	2[c]
		Species is important in nutrient cycling or food chain dynamics (since all species are components of an ecosystem this is the minimum baseline score)	1[c]
			Max. points = 10
Economic/ cultural importance	Consumptive (furbearers)	Species is one of top five species ranked by average total dollar value of pelts sold for the preceding 5 years	5
		Species is ranked sixth through tenth by average total dollar value of pelts sold for the preceding 5 years	4
		Species is trapped but not ranked in the top 10 by average total dollar value of pelts sold for the preceding 5 years	3
	Consumptive (non-furbearers)	Significant harvest of species by subsistence users	5
		Significant harvest of species by resident sport hunters	4
		Significant harvest of species by non-resident hunters	3
		Some limited harvest of species by subsistence users, resident or non-resident sport hunters	2

Table 4. Concluded

Merit category	Merit sub-category	Criteria	Score[a]
		Species harvested for non-game purposes (pet trade, scientific supply houses, etc.)	1
		No known harvest	0
	Cultural/ aesthetic	Species is symbolically important to one or more cultural groups within the province or is considered an international destination species in the wildlife viewing tourism industry (e.g., polar bear)	5
		Species provides significant viewing opportunities	3
		Species provides some viewing opportunities	1
		Species not considered to provide viewing opportunities	0
			Max. points = 10
Knowledge of species	Model development	HSI model has been developed for the species	4
		Life requisite and habitat relationship information required for modeling is available in the literature, including information derived from Manitoba population of the species	3
		Life requisite and habitat relationship information required for modeling is available but Manitoba-based data is unavailable	2
		Some life requisite and habitat relationship information is available but may be incomplete for modeling purposes	1
		Life requisite and habitat relationship information is unavailable	0
	Monitoring	Population is monitored in areas representative of the species range in the province	3
		Population is monitored locally where management problems exist	2
		Population is not currently monitored but monitoring is technically and economically feasible	1
		Monitoring is not feasible because population estimates are too costly or impossible to obtain	0
	Distribution	Distribution is well known and occurrence can be accurately predicted throughout the range of the species	3
		Broad range limits or habitat associations are known, but local occurrence cannot be predicted with accuracy	2
		Manitoba distribution is extrapolated from a few locations or knowledge limited to general range maps	1
Sensitivity to impact		Species is highly negatively impacted by habitat modifications resulting from forest management decisions	10
		Species is moderately negatively impacted by habitat modifications resulting from forest management decisions	5
		Species is not affected by habitat modifications resulting from forest management decisions	1
			Max. points = 10
		Maximum total points for all categories and sub-categories = 50	

[a] Only one score can be selected per sub-category unless otherwise specified.

[b] The rare category was discontinued by COSEWIC in 1990; however, the selection process was initiated prior to this change.

[c] More than one score for this sub-category can be selected—maximum of 6 points.

a species' life history: its period of occurrence in Manitoba; degree of population concentration; and the importance of the species in the ecosystem.

Scores in the subcategory for period of occurrence recognize that management actions can have greater impact on populations that are resident year round than on populations that are transient or resident during a portion of the year only. Similarly, populations that must congregate for part of their life cycle—breeding or hibernation, for example—can be particularly vulnerable to loss of individuals when their habitat is disturbed. This is especially true when there is some special feature of the area that facilitates the congregation. Bat caves, snake hibernacula, and winter range for some ungulates are examples.

All species play a role in nutrient cycling or food chain dynamics within an ecosystem but some species contribute directly to creating or maintaining life requisites for other species on a local or community scale. The third subcategory rates the importance of each species within its ecosystem. A species could conceivably have general, local, and community importance, thus more than one descriptor could apply; the score in this subcategory was calculated as the sum of the scores for all applicable descriptors.

Scores from all three subcategories were then summed to provide a final ecology score.

Economic/Cultural Importance

The third merit category groups economic and cultural importance and balances consumptive and non-consumptive use by giving equal weight to each of the two subcategories. Consumptive use was further subdivided to distinguish between species whose primary economic value is derived from trapping and those whose value lies in subsistence or sport harvest.

Furbearing species were scored based on the average total dollar value of pelts sold in the preceding 5 years.

The Manitoba Department of Natural Resources policy of providing first for subsistence users, second for resident hunters, and third for non-resident hunters provided the basis for scoring consumptive use of non-furbearing species. Species that are significantly harvested by First Nations received the highest scores because First Nations peoples are the largest group of subsistence hunters in the province. Consumptive use also includes harvest of species such as frogs and snakes for the pet trade and for scientific supply houses or other non-game purposes. These species were given the lowest score in this subcategory because such uses are not economically important in Manitoba.

A few species, such as black bear, are important for both sport harvest and fur production; however, each species was scored using only one set of criteria, based on which use was the most economically significant. The sport harvest for black bear is more economically important to the province than the fur harvested by trappers, therefore this species was scored using the criteria for non-furbearers.

The non-consumptive merit subcategory ranked species based on cultural importance or the significance of wildlife viewing and eco-tourism opportunities provided by the species. Species that are symbolically important to a cultural group, or that are considered an international destination species to the wildlife viewing tourism industry were given the highest score.

The bald eagle is an example of a species with tremendous cultural importance to First Nations in Manitoba. It also provides significant wildlife viewing opportunities in areas where it congregates. Each species was given the score of the highest scoring descriptor that could be applied within this subcategory.

Scores from the applicable consumptive subcategory and the cultural/aesthetic subcategory were summed to provide the overall score for the Economic/Cultural Importance merit category. A species with consumptive use but without a non-consumptive use, or vice versa, could score a maximum of only half the total points available for this merit category.

Knowledge of Species

The ability to develop habitat suitability indexes for a given species depends on the researchers' knowledge of the animal's requirements. How much is known about the species can be important criterion in selecting emphasis species where there is a need to justify additional research funding. In

the fourth merit category, species are scored according to the availability of existing data for developing a model; the ability to monitor a species for model validation purposes; and the ability to predict the occurrence of a given species within a specific area.

In the first subcategory, model development, the highest scores were given to species for which an HSI model had already been developed, or if life requisite and habitat relationship information for Manitoba populations were available to develop models. The existence of an HSI model developed in another jurisdiction was used again further on in the species selection process. The MFWMP believed this would hasten the completion of a model by providing general guidelines and a potential source of expertise to develop a model.

Scores in the second subcategory, monitoring, were weighted according to existing monitoring effort or technical and economic feasibility of monitoring. The lowest score was given those species for which monitoring is not feasible, because population estimates are too difficult or costly to obtain.

In the third subcategory, distribution, species were scored in accordance with the reliability of range and habitat association information. Each species was given the score of the highest scoring descriptor that could be applied in each subcategory; scores for all the subcategories were summed to provide the overall score in this category.

The final category, Sensitivity to Impact, measured the tolerance of a species to habitat disturbance. All species are affected somewhat by forest management. Each species was evaluated for its tolerance to habitat modification; those that were most sensitive to disturbance received the highest scores. The highest weight assigned to this category is equal to the weight assigned endangered species in the first merit category, for it is the loss of habitat that most frequently leads to the listing of species by COSEWIC. As in most of the previous categories and subcategories, each species was assigned the score of the highest scoring descriptor.

REDUCING THE NUMBER OF EMPHASIS SPECIES: SPECIES RANKING

Each species was assigned a score for each of the five merit categories; rankings were determined based on the sum of the scores from all merit categories. The score for each merit category could not exceed 10 points, and the sum of the scores from all merit categories (maximum score = 50) represented the overall merit evaluation score for a species.

The scoring was performed by the MFWMP with assistance from species authorities. Merit evaluation scores by merit category and subcategory for the 137 species considered for modeling are shown in Appendix 4. Those species with higher merit evaluation scores would be, in theory, better suited as emphasis species for the boreal ecozones of Manitoba. Ranked total merit evaluation scores for the 137 species considered for modeling are shown in Appendix 5.

Merit evaluation scores ranged from a minimum of eight to a maximum of 37. The distribution of merit evaluation scores indicated that fewer species were represented by scores above the mean score of 14 than below the mean (Fig. 2). Two-thirds of the species scored at or below the mean and were clustered within a range of six points. Forty-five species scored above the mean within a range of 22 points, almost four times greater than the range of those species scoring below the mean.

The observed distribution is consistent with the distribution that was expected for this faunal assemblage: most species were not particularly at risk, and only a small number of species were either at risk or significant to society. The alternative hypothesis is that the closeness of scores, and the preponderance of one score, for the bottom two-thirds of the species ranked reflects insensitivity of, or uncertainties in, the ranking system. This hypothesis, however, seems to be precluded by the degree of separation of those scoring above the mean. The degree of separation of the species scoring higher than the mean was considered acceptable and the number of potential emphasis species was reduced to 45 (Table 5).

The top 11 emphasis species (Table 5) all have existing HSI models that were developed elsewhere

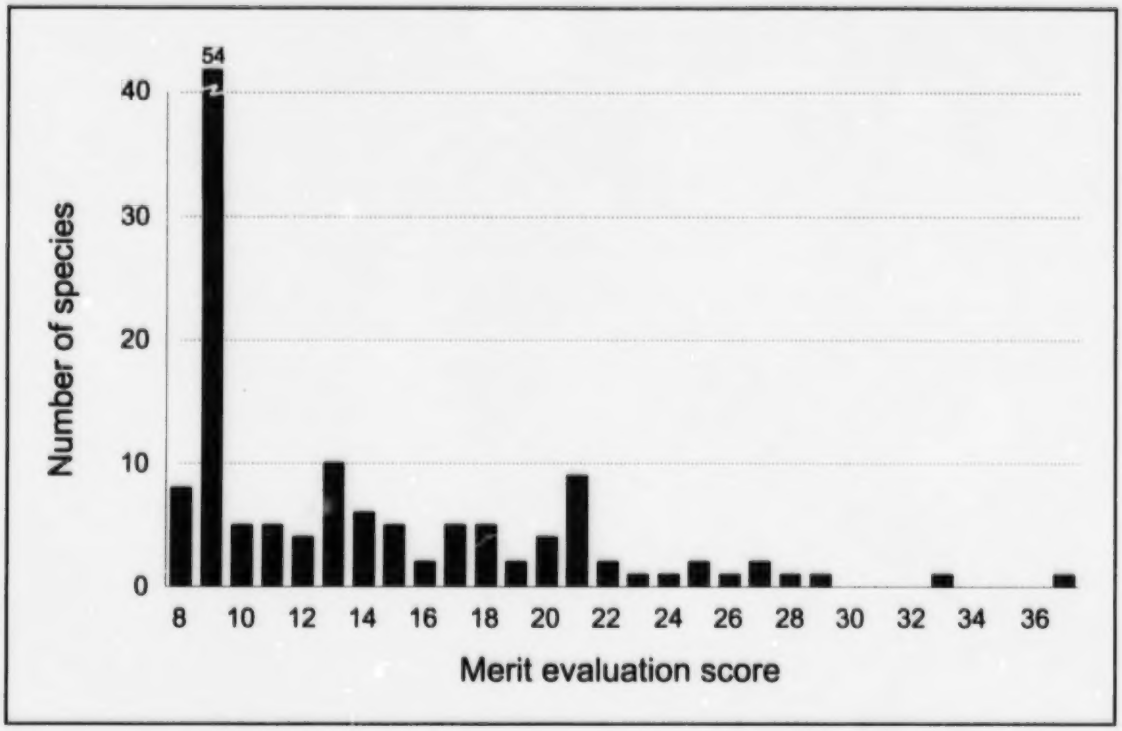


Figure 2. Distribution of Merit Evaluation Scores of 137 species considered for modeling.

in North America. These species were selected for model development because modifying an existing model to reflect conditions in Manitoba would hasten the completion of a model, by providing general guidelines and a potential source of expertise. The other nine species with existing HSI models were selected for model development to broaden the choices available to the MFWMP.

The MFWMP examined the distribution of life requisite information of these 20 emphasis species among habitat associations (Table 6). Elk (*Cervus elaphus*) was removed because of its limited geographic range (a characteristic not captured by the distribution of life requisite information among the habitat elements but considered during the selection process). The bald eagle (*Haliaeetus leucocephalus*) was deleted because not all its life requirements were met by the 30 cover types. The fisher (*Martes pennanti*) is a commercially important furbearer but also a habitat generalist. The great blue heron (*Ardea herodias*) and the wood duck (*Aix sponsa*) are primarily riparian species and were dropped because they are too specific to a cover type that already has five other species that can rely on this cover type for their life requisites.

Four of the remaining six species have life requisites that are met within the same habitat types (shaded portions of Table 6). The downy woodpecker (*Picoides pubescens*), the ovenbird (*Seiurus aurocapillus*), and the belted kingfisher (*Ceryle alcyon*) all have life requisites that are within the habitat types required by the hairy woodpecker (*Picoides villosus*) for its life requisites. The hairy woodpecker was retained because its merit evaluation score was higher than those of the other species, except for the downy woodpecker, which has an identical score (Table 6). The hairy woodpecker was preferred over the downy woodpecker, however, because of the former's more observable nature and greater ease in counting because of its more frequent calling.

The habitats required by the black-capped chickadee (*Parus atricapillus*) were viewed as a subset of the habitats required by the ruffed grouse (*Bonasa umbellus*). The habitats required by the

Table 5. Working list of emphasis species

Species	Merit Evaluation Score	Has an HSI model been developed elsewhere in North America?
Woodland caribou	37	Yes
Moose	33	Yes
Great gray owl	29	Yes
Red squirrel	28	Yes
Marten	27	Yes
Pileated woodpecker	27	Yes
White-tailed deer	26	Yes
Bald eagle	25	Yes
Elk	25	Yes
Beaver	24	Yes
Fisher	23	Yes
Bufflehead	22	No
Common goldeneye	22	No
Black bear	21	No
Blue-spotted salamander	21	No
Downy woodpecker	21	Yes
Great blue heron	21	Yes
Hairy woodpecker	21	Yes
Northern redbelly snake	21	No
Ruffed grouse	21	Yes
Sharp-tailed grouse	21	No
Wolf	21	No
Common merganser	20	No
Hooded merganser	20	No
Mink	20	No
Northern hawk-owl	20	No
Cooper's hawk	19	No
Wood duck	19	Yes
Common raven	18	No
Cope's gray treefrog	18	No
Gray treefrog	18	No
Osprey	18	No
Wood frog	18	No
Black-backed woodpecker	17	No
Lynx	17	No
Northern flicker	17	No
Ovenbird	17	Yes
Three-toed woodpecker	17	Yes
Wolverine	16	No
Yellow-bellied sapsucker	16	No
American crow	15	No
Belted kingfisher	15	Yes
Black-capped chickadee	15	Yes
Boreal owl	15	No
Northern goshawk	15	No

Table 6. Habitat associations of the 20 species from the emphasis species working list that have existing HSI models developed elsewhere in North America

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)						MES[a]
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	
Woodland caribou	–[b]	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	–	A	A	A	A	A	37
Moose	A	FU	–	–	A	–	F	F	FC	–	–	–	A	A	C	–	–	–	A	C	C	–	–	–	C	C	–	–	–	–	33
Great gray owl	–	F	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	A	–	A	A	A	A	A	–	A	A	A	A	A	29
Red squirrel	A	–	FC	FC	–	–	–	–	C	C	C	–	–	–	FC	FC	FC	–	–	–	A	A	A	–	–	–	A	A	A	–	28
Marten	A	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	27
Pileated woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	27
White-tailed deer	–	–	–	–	A	A	A	A	A	–	–	–	A	A	–	–	–	–	–	–	C	–	–	–	–	–	–	–	–	–	26
Bald eagle	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	R	–	–	–	R	R	R	–	–	–	25
Elk	F	–	–	–	–	FR	FR	FC	–	–	–	–	CR	CR	–	–	–	–	CR	R	–	–	–	–	CR	R	–	–	–	–	25
Beaver	A	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
Fisher	A	–	FC	FC	FC	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	23
Downy woodpecker	**F**	**–**	**–**	**–**	**F**	**–**	**F**	**F**	**F**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**21**
Great blue heron	A	F	F	R	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
Hairy woodpecker	**F**	**–**	**–**	**–**	**F**	**–**	**F**	**F**	**F**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**21**
Ruffed grouse	**A**	**–**	**–**	**–**	**A**	**F**	**A**	**A**	**A**	**A**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**21**
Wood duck	A	F	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19
Ovenbird	**F**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**17**
Three-toed woodpecker	–	–	A	–	F	–	–	F	F	–	–	–	–	–	A	A	A	–	F	F	A	A	A	–	F	F	A	A	A	–	17
Belted kingfisher	**F**	**F**	**–**	**–**	**F**	**–**	**F**	**F**	**–**	**–**	**–**	**–**	**F**	**A**	**A**	**–**	**–**	**–**	**F**	**A**	**A**	**–**	**–**	**–**	**F**	**A**	**A**	**–**	**–**	**–**	**15**
Black-capped chickadee	**A**	**–**	**–**	**–**	**A**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**A**	**A**	**A**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**15**

[a] Merit Evaluation Score.

[b] Dashes indicate the species has no association with the habitat type for its life requisites.

Note: RI = riparian; MB = marsh–bog; TM = treed muskeg; TR = treed rock; WA = willow–alder; GF = grass–forbs; H = hardwoods; DM = deciduous-dominated mixedwoods; CM = coniferous-dominated mixedwood; SSP = softwood spruce; SJP = softwood jack pine; SL = softwood larch; R = reproduction; F = feeding; C = cover; A = provides all life requisites; U = provides for unique requirements.

former are the same as those required by the latter, except for the ruffed grouse's ability to meet its life requirements in cover types within the mature–overmature successional stage (Table 6). The ruffed grouse was retained because its merit evaluation score is substantially higher (21 versus 15).

This step in the species selection process resulted in 11 emphasis species, six of which are mammals. Because there were no further species in the emphasis species working list that have HSI models developed elsewhere in North America, the MFWMP proceeded with the selection of indicator species.

REDUCING THE NUMBER OF INDICATOR SPECIES: SPECIES RANKING

Each wildlife species exhibits a different degree of versatility (adaptability) in the number of plant communities and successional stages it can use for feeding and reproduction (Thomas 1979). Species with strong associations to a specific cover type and successional stage could serve as habitat indicators. The process used to narrow the number of indicator species used a versatility index (after Thomas 1979) that was derived for each of the 137 species by determining the total number of cover types and successional stages to which each species shows preference for feeding and reproduction.

Versatility indexes were calculated as:

$$Vi = [Cr + Sr] + [Cf + Sf]$$

where:

Cr is the number of cover types to which the species shows preference for reproduction;

Sr is the number of successional stages to which the species shows preference for reproduction;

Cf is the number of cover types the species uses for feeding; and

Sf is the number of successional stages the species uses for feeding.

From Table 6, for example, the versatility index for marten is:

$$Vi = [4 + 3] + [4 + 3] = 14.$$

Note that non-commercial forested lands (Table 6) are not considered a successional stage because vegetation on these lands does not progress through distinct stages of succession because of their much slower-growing nature. These lands are, however, important habitat for many species and form an important component in maintaining biodiversity across the greater landscape.

Figure 3 shows the distribution of versatility indexes for the 137 species considered for modeling. They range from a minimum of two for the common nighthawk (*Chordeiles minor*) to a maximum of 30 for mink (*Mustela vison*). The mean versatility index is 14. Versatility indexes for all 137 species are shown ranked in Appendix 6. Because of the distribution of versatility index scores with almost the same number of species above the mean as below the mean,[3] there was no apparent break point that could be used to create a subset of the 137 species to consider for modeling as had been the case for emphasis species.

The MFWMP selected emphasis species that had HSI models developed elsewhere in North America to reduce the number of potential indicator species. However, species that were already selected as emphasis species were not considered for selection as indicator species. The MFWMP felt that selecting additional species would increase the probability that the final species selected for modeling would collectively require a broader range of habitats for their life requisites than would fewer species acting as both emphasis and indicator species. Species that were rejected as emphasis species were not considered for selection as indicator species because of the similarity of their life requisites to those species already chosen as emphasis species (Table 6).

[3] The distribution of versatility index scores does not follow a statistically normal distribution. A Shapiro-Wilk test on the distribution of versatility index scores results in a probability value ($Pr < W$) of 0.0107.

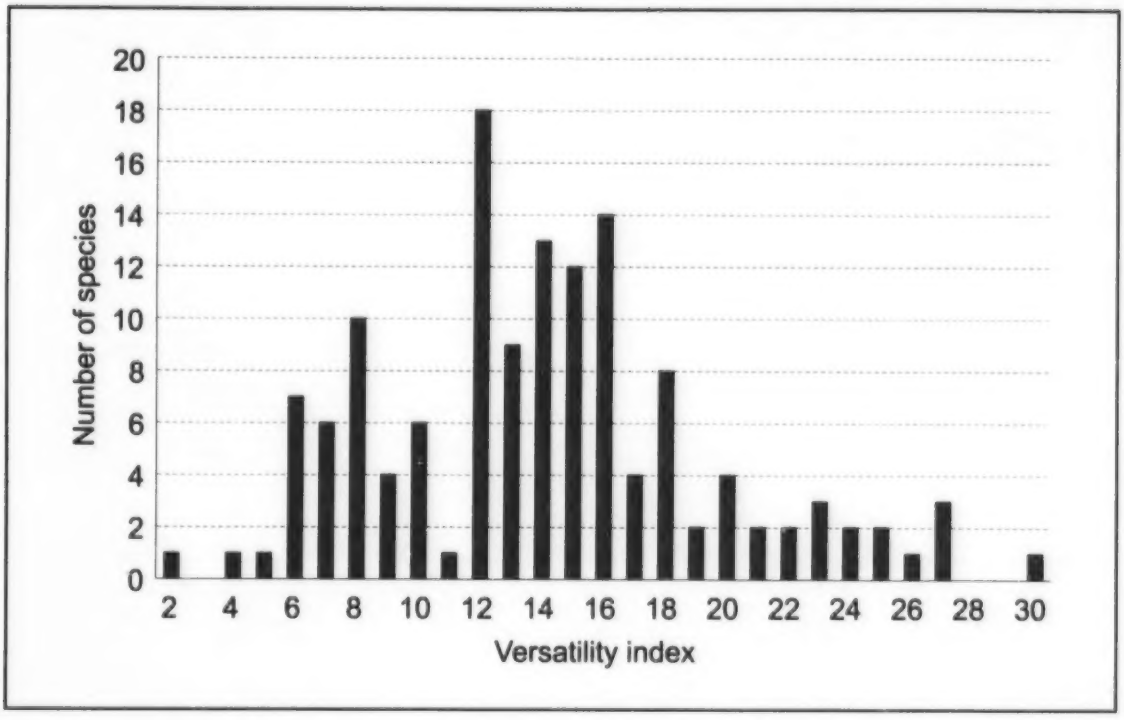


Figure 3. Distribution of versatility indexes of 137 species considered for modeling.

Interestingly, all the remaining species that have existing HSI models are birds (Table 7). Studies of boreal forest fauna suggest that 72% of the vertebrate species are birds (Smith 1993), and many emphasis species are mammals. This is fortuitous, because the MFWMP believed the species selected in this process should be representative of the natural species composition of the boreal forest. In this way, it can be one of many guidelines to which forest managers can refer, in their efforts to keep the forest in as natural a state as possible.

Askins et al. (1990) and Robbins et al. (1989) suggested that alarming declines in neotropical migrants have occurred in part because of their sensitivity to forest fragmentation and the general decline of suitable habitat. These trends suggest that neotropical migrants are good choices for indicator species. This new group of 16 species (11 emphasis species and five indicator species) was then evaluated in terms of their distribution among the successional stages and cover types of their habitat associations (Table 7) because there were no additional species that have HSI models developed elsewhere in North America.

The shrub–seedling successional stage has the lowest number of species, and the lowest average number of species per cover type, of all the successional stages (Table 7). The MFWMP sought to increase the number of species with life requisites that can be met by this successional stage. However, the selection committee was also aware that a more or less even distribution of species among successional stages is not desirable (nor likely possible) because of differences in vertical structure and number of plant species present between successional stages.

Because older successional stages are also under greater timber harvesting pressure, it is essential that more species requiring older successional stages for their life requisites be selected, to ensure that harvesting plans leave sufficient habitat for the continued existence of these species.

The MFWMP proceeded to fulfill these two goals by examining bird species that can have life requisites met by cover types within the shrub–seedling successional stage, but also by older successional stages.

Table 7. Indicator species, which have existing HSI models developed elsewhere in North America, added to the selected emphasis species

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)						VI[a]
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	
Woodland caribou	–[b]	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	–	A	A	A	A	A	ES[c]
Moose	A	FU	–	–	A	–	F	F	FC	–	–	–	A	A	C	–	–	–	A	C	C	–	–	–	C	C	–	–	–	–	ES
Great gray owl	–	F	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	A	–	A	A	A	A	A	–	A	A	A	A	A	ES
Red squirrel	A	–	FC	FC	–	–	–	–	C	C	C	–	–	–	FC	FC	FC	–	–	–	A	A	A	–	–	–	A	A	A	–	ES
Pileated woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	ES
Marten	A	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	ES
White-tailed deer	–	–	–	–	A	A	A	A	A	–	–	–	A	A	–	–	–	–	–	–	C	–	–	–	–	–	–	–	–	–	ES
Beaver	A	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ES
Ruffed grouse	A	–	–	–	A	F	A	A	A	A	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	ES
Hairy woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	ES
Three-toed woodpecker	–	–	A	–	F	–	–	F	F	–	–	–	–	–	A	A	A	–	F	F	A	A	A	–	F	F	A	A	A	–	ES
Common yellowthroat	FC	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
Yellow warbler	A	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
Magnolia warbler	FC	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
Barred owl	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	10
Golden-crowned kinglet	–	–	A	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	12
Number of species that have life requirements met by cover type	6	2	4	0	6	1	5	4	3	2	0	0	7	8	6	4	2	1	5	5	8	6	5	2	4	6	8	6	5	2	
Average number of species per cover type per successional stage	3.6					2.1							4.7						5.2						5.2						

[a] Versatility index.

[b] Dashes indicate the species has no association with the habitat type for its life requisites.

[c] Emphasis species.

Note: RI = riparian; MB = marsh–bog; TM = treed muskeg; TR = treed rock; WA = willow–alder; GF = grass–forbs; H = hardwoods; DM = deciduous-dominated mixedwoods; CM = coniferous-dominated mixedwood; SSP = softwood spruce; SJP = softwood jack pine; SL = softwood larch; R = reproduction; F = feeding; C = cover; A = provides all life requisites; U = provides for unique requirements.

The red-breasted nuthatch (*Sitta canadensis*) was selected from a list of indicator species with life requisites that can be met by any of the shrub–seedling, pole–sapling, intermediate, and mature–overmature successional stages (Table 8). It was preferred over the indigo bunting (*Passerina cyanea*) because of its greater geographic range within the province. However, the habitat requirements of the red-breasted nuthatch are almost identical to those of the golden-crowned kinglet (*Regulus satrapa*). This near duplication of habitat requirements suggested that the selection of the red-breasted nuthatch may be inappropriate. The red-breasted nuthatch remained a selected species pending further investigation.

Attention turned to specific cover types that have no species that require them for their life requisites. These cover types are treed rock in the non-commercial forest land successional stage, and jack pine (*Pinus banksiana* Lamb.) and larch (*Larix* sp.) in the shrub–seedling successional stage (shaded portions of Table 7). Because jack pine cover types are among the most common cover types, the MFWMP concentrated initially on selecting a species that requires this cover type for its life requisites. A list of bird species that can use the jack pine cover type in the shrub–seedling successional stage for their life requisites is shown in Table 9.

All the species except the palm warbler (*Dendroica palmarum*) were judged to be too general in their habitat requirements to have any value as indicator species, as reflected by their high versatility index scores. The palm warbler is commonly found within other shrub–seedling cover types but is not found in older successional stages (Table 10).

Because the MFWMP sought to increase the number of species in older successional stages, other species were sought that can meet this goal as well as requiring the cover types for which no species had yet been selected. An additional factor that contributed to the deletion of the palm warbler is that there were several other species already selected that can use the jack pine cover type in older successional stages.

All the species, except for the palm warbler, that can use the larch cover type in the shrub–seedling successional stage also appear in Table 9. Because they were already judged to be too general in their habitat requirements to have any value as indicator species, species selections for the larch cover type in the shrub–seedling successional stage were not sought.

The selection committee then turned to finding species that can use the treed rock cover type. The Nashville warbler (*Vermivora ruficapilla*) was chosen over the other species that can use the treed rock cover type, because it has the lowest versatility index, other than that of the common nighthawk (Table 10). The common nighthawk has the lowest

Table 8. Bird species with habitat requirements met by any of the shrub–seedling, pole–sapling, intermediate, and mature–overmature successional stages

Species	Versatility index	Species	Versatility index
Indigo bunting	10	Dark-eyed junco	16
Red-breasted nuthatch	12	Hermit thrush	16
Boreal chickadee	14	Northern hawk-owl	16
Blackburnian warbler	14	Philadelphia vireo	16
Black-throated green warbler	14	Red-eyed vireo	16
Eastern wood peewee	14	Cedar waxwing	17
Western wood peewee	14	Least flycatcher	17
Gray jay	15	Swainson's thrush	17
Pine siskin	15	Blue jay	18
White-throated sparrow	15	Common raven	18
American crow	16	Veery	18
Blackpoll warbler	16	Whip-poor-will	18
Black-and-white warbler	16	Ruby-crowned kinglet	19
Common redpoll	16		

Table 9. Bird species that may use the jack pine cover type in the shrub–seedling successional stage

Species	Versatility index
Palm warbler	16
Spruce grouse	23
Long-eared owl	24
Mourning dove	25
Great horned owl	27
Sharp-tailed grouse	27

versatility index of all the species considered for modeling (Appendix 6). However, the common nighthawk was dropped from consideration, because of the MFWMP's overriding objective of increasing the number of species with life requisites that can be met by older successional stages.

The addition of the red-breasted nuthatch and the Nashville warbler brought the number of selected species to 18, which the MFWMP felt represented a manageable cross section of species resident in the boreal forest. Once this was done, the committee considered which, if any, additional species to select.

Table 10. Bird species that may use the treed rock cover type

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)						Stands at pole–sapling stage (11–39 years old)			Stands at intermediate stage (40–69 years old)			Stands at mature to overmature stage (70+ years old)			VI[a]
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	DM	CM	SSP	DM	CM	SSP	DM	CM	SSP	
Common nighthawk	–[b]	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Nashville warbler	–	–	A	A	–	–	–	A	A	–	–	A	A	–	–	–	–	–	–	–	12
Bonaparte's gull	–	–	A	A	–	A	–	–	–	–	–	–	–	A	–	–	A	–	–	A	14
Common redpoll	–	–	–	A	–	–	–	A	A	–	–	A	A	A	A	A	A	A	A	–	16
Palm warbler	FC	FC	FC	F	F	F	F	FC	A	A	A	–	–	–	–	–	–	–	–	–	16

[a] Versatility index.

[b] Dashes indicate the species has no association with the habitat type for its life requisites.

Note: RI = riparian; MB = marsh–bog; TM = treed muskeg; TR = treed rock; WA = willow–alder; GF = grass–forbs; H = hardwoods; DM = deciduous- dominated mixedwoods; CM = coniferous-dominated mixedwood; SSP = softwood spruce; SJP = softwood jack pine; F = feeding; C = cover; A = provides all life requisites; U = provides for unique requirements.

FINAL SELECTION OF SPECIES

During an initial HSI modeling seminar, an experienced Manitoba bird naturalist suggested that the black-and-white warbler (*Mniotilta varia*) would be an excellent indicator species for denizens of mixedwood forests. It also meets the goal of selecting species that can have life requisites met by cover types not only within the shrub–seedling successional stage but also by any of the older successional stages (Table 8). The naturalist's experience with songbird censuses also revealed that the secretive nature of the golden-crowned kinglet makes this species difficult to monitor in the field. The ruby-crowned kinglet (*Regulus calendula*) occupies a similar niche and is much easier to monitor. The golden-crowned kinglet was therefore replaced by the latter (Table 11). As mentioned earlier, the habitat requirements of the red-breasted nuthatch are almost identical to those of the golden-crowned kinglet, so this move also lessened the duplication of habitat requirements.

At another point during the species selection process, the suggestion was made to place a diurnal predatory bird species, the northern goshawk (*Accipiter gentilis*), on the list of selected species. It was later dropped because, like the golden-crowned kinglet, it is difficult to observe and monitor in the field. The difficulty involved in observing and monitoring a species in the field (particularly birds) became a consideration for selection because

Table 11. Final species selections for HSI model development in Manitoba

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)						VI[a]
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	
Woodland caribou	–[b]	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	–	A	A	A	A	A	ES[c]
Moose	A	FU	–	–	A	–	F	F	FC	–	–	–	A	A	C	–	–	–	A	C	C	–	–	–	C	C	–	–	–	–	ES
Great gray owl	–	F	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	A	–	A	A	A	A	A	–	A	A	A	A	A	ES
Red squirrel	A	–	FC	FC	–	–	–	–	C	C	C	–	–	–	FC	FC	FC	–	–	–	A	A	A	–	–	–	A	A	A	–	ES
Pileated woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	ES
Marten	A	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	ES
White-tailed deer	–	–	–	–	A	A	A	A	A	–	–	–	A	A	–	–	–	–	–	–	C	–	–	–	–	–	–	–	–	–	ES
Beaver	A	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ES
Ruffed grouse	A	–	–	–	A	F	A	A	A	A	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	ES
Hairy woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	ES
Three-toed woodpecker	–	–	A	–	F	–	–	F	F	–	–	–	–	–	A	A	A	–	F	F	A	A	A	–	F	F	A	A	A	–	ES
Common yellowthroat	FC	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
Yellow warbler	A	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
Magnolia warbler	FC	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
Barred owl	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	10
Nashville warbler	–	–	A	A	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
Red-breasted nuthatch	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	12
Black-and-white warbler	F	–	–	–	F	–	A	FC	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	a	–	–	–	16
Ruby-crowned kinglet	FC	–	A	–	FC	–	A	A	A	–	–	–	–	–	A	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	19
Number of species that have life requirements met by cover type	6	2	4	1	6	1	7	5	6	2	0	0	7	9	9	5	2	1	5	5	10	7	5	2	4	6	10	7	5	2	
Average number of species per cover type per successional stage	3.8					3.0							5.5						5.7						5.7						

[a] Versatility index.

[b] Dashes indicate the species has no association with the habitat type for its life requisites.

[c] Emphasis species.

Note: RI = riparian; MB = marsh–bog; TM = treed muskeg; TR = treed rock; WA = willow–alder; GF = grass–forbs; H = hardwoods; DM = deciduous-dominated mixedwoods; CM = coniferous-dominated mixedwood; SSP = softwood spruce; SJP = softwood jack pine; SL = softwood larch; R = reproduction; F = feeding; C = cover; A = provides all life requisites; U = provides for unique requirements.

validation studies will be performed for all species. These will determine if an HSI model's assignment of habitat quality is verified by wildlife productivity and use patterns.

When the final 13 emphasis and indicator bird species were chosen, the breakdown was: two predators (great gray owl and barred owl); three woodpeckers (pileated, hairy, and three-toed); five warblers (common yellowthroat, yellow, magnolia, Nashville, and black and white); and red-breasted nuthatch, ruby-crowned kinglet, and ruffed grouse. It was not possible to select species for all 30 cover types condensed from the FRI because species that are dependent on some of these cover types are too general in their habitat requirements to be suitable as indicator species.

The jack pine and larch cover types in the shrub–seedling successional stage have no species in the selected species list, while the treed rock cover type in the non-commercial forest land stage and the larch cover type in the pole–sapling stage have only one species each. All other cover types have at least two species, while several other cover types have as many as 10 species.

SUMMARY

Two hundred and fifty-six vertebrate species that occur in Manitoba's boreal forest for all or part of their life requisites were categorized for the species selection process. Plants and insects were not considered for modeling, chiefly because of the paucity of knowledge regarding their distribution and habitat usage. Additionally, the high number of plants and insects would put a selection process beyond the resources available to the MFWMP. For plants alone, an estimated 2500 species grow in the boreal forest. The objective of the species selection process was to select enough vertebrate species from the full spectrum of habitat types to act as a cross section of all wildlife found in the boreal forest.

The development of habitat types was the first step in the selection process. The many distinct habitats described by the provincial FRI were condensed into a manageable number of habitat types to form the foundation for the species selection process. Twelve more general steps were taken to arrive at the 19 species the MFWMP believed to be a good balance between emphasis and indicator species, and between birds and mammals (Table 12). These steps are summarized in Figure 4.

A check of the habitat associations of the selected species shows that only two pairs of species share habitat preferences. These were beaver and common yellowthroat, and hairy woodpecker and black-and-white warbler; each pair consists of an emphasis and indicator species.

Heavy emphasis was placed on species for which HSI models were developed elsewhere in North America (15 of 19 selected species). It was thought that modifying an existing model to reflect conditions in Manitoba would hasten the completion of a model by providing general guidelines and a potential source of expertise. The eventual selection of enough species that collectively required as many habitat types as possible served as the logical end to the selection process. The resources available to the MFWMP were a secondary factor limiting the number of species that could be selected for modeling.

An underlying assumption of the species selection process is that wildlife will be present if the right habitat exists for them. Validation studies to determine how well a model's assignment of habitat quality is reflected by wildlife productivity and use patterns are critical to test this assumption. Validation studies are necessary steps toward adoption of HSI models intended for practical forest management. Several validation projects funded through the MFWMP have been completed or are underway. Each validation project is viewed as a stand-alone project; no comprehensive validation program has been developed, although existing data and information collected by various wildlife management agencies have been used wherever possible.

Other factors such as population cycles, climate, and hunting pressure influence wildlife productivity and use patterns. These factors may confound the results of a single validation study. Habitat alterations along migration routes and on wintering grounds are an additional, potentially significant, factor that could affect the populations of migratory birds (six of the bird species selected

Table 12. Summary of final species selections for HSI model development in Manitoba

Species	Emphasis species		Indicator species		Has an HSI model been developed elsewhere in North America?
	Merit Evaluation Score	Versatility index	Merit Evaluation Score	Versatility index	
Woodland caribou	37	16	–[a]	–	Yes
Moose	33	13	–	–	Yes
Great gray owl	29	17	–	–	Yes
Red squirrel	28	15	–	–	Yes
Marten	27	14	–	–	Yes
Pileated woodpecker	27	14	–	–	Yes
White-tailed deer	26	14	–	–	Yes
Beaver	24	8	–	–	Yes
Hairy woodpecker	21	15	–	–	Yes
Ruffed grouse	21	21	–	–	Yes
Three-toed woodpecker	17	18	–	–	Yes
Common yellowthroat	–	–	9[b]	7	Yes
Yellow warbler	–	–	9[b]	8	Yes
Magnolia warbler	–	–	9[b]	9	Yes
Barred owl	–	–	14[b]	10	Yes
Nashville warbler	–	–	9[b]	12	No
Red-breasted nuthatch	–	–	13[b]	12	No
Black-and-white warbler	–	–	9[b]	16	No
Ruby-crowned kinglet	–	–	9[b]	19	No

[a] Dashes indicate not applicable.

[b] Not on the emphasis species working list of 47 species.

for modeling are migratory). No single validation effort should be viewed as a final vindication of the accuracy or appropriateness of a model. An on-going, iterative process of validation (population monitoring) and model refinement, particularly the incorporation of research on species spatial requirements, is required to ensure the continued usefulness of a model.

The selected species list is not viewed as unalterable. Recent expansions in the forest industry of the west-central part of the province, for example, have prompted concerns about the elk population resident in that area. The elk has since been added to the list of selected species. The species selection process is a guide that can readily be changed through additions or substitutions to meet the needs of local resource managers, reflect provincial priorities, or to incorporate new research findings.

Wildlife is a component of biological diversity, and its conservation through the use of HSI models, integrated with forest management planning, is only one of many ways that the long-term decline of biological diversity can be mitigated or prevented.

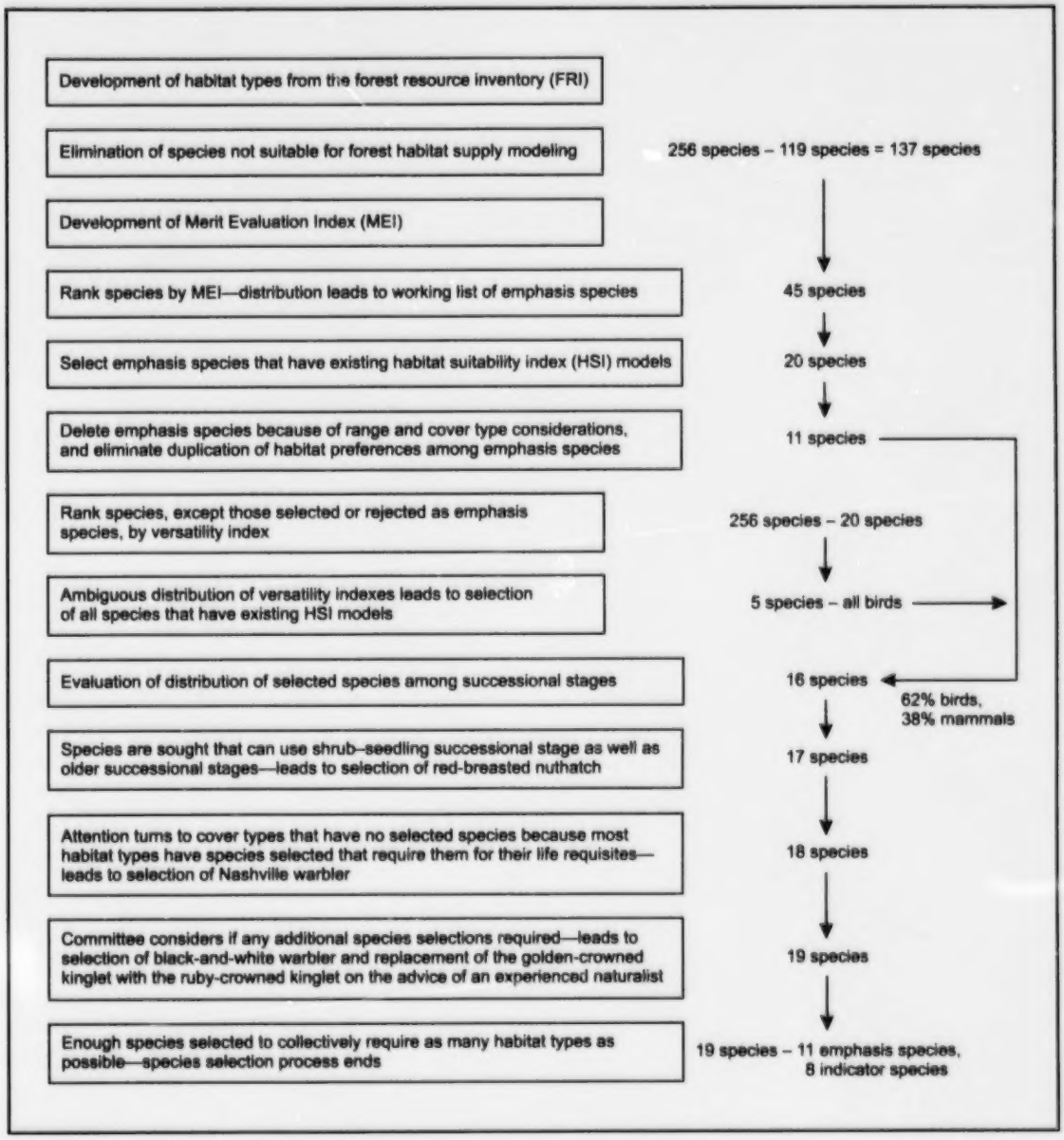


Figure 4. An outline of the 13 general steps of the species selection process.

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APPENDIX 1
COMPONENTS OF THE STAND AGGREGATE IN THE MANITOBA FOREST RESOURCE INVENTORY

A. Cover Type Classifications

Code	Cover type description
0–3	Softwoods (S). Includes all stands where at least 76% of the total basal area consists of coniferous species.
4–7	Softwood–hardwood mixedwoods (M). Includes all stands where the basal area of coniferous species is between 51% and 75% of the total basal area.
8	Hardwood–softwood mixedwoods (N). Includes all stands where the basal area of coniferous species is between 26% and 50% of the total basal area.
9	Hardwoods (H). Includes all stands where the basal area of coniferous species is less than 25% of the total basal area.

B. Subtype by Cover Type and Species Composition

Subtype	Cover type	Species composition
01	Softwood (S)	Red pine 71–100%
02	Softwood (S)	Red pine 40–70%; 2nd major species jack pine
41	Softwood–Hardwood (M)	Red pine 51%; 2nd major species hardwood
42	Softwood–Hardwood (M)	Red pine 50% or less; 2nd major species jack pine; 3rd major species hardwood
43	Softwood–Hardwood (M)	White pine 51%+; 2nd major species hardwood
04	Softwood(S)	Jack pine 71–100%
05	Softwood(S)	Jack pine 40–70%; 2nd major species red pine
06	Softwood(S)	Jack pine 40–70%; 2nd major species spruce
44	Softwood–Hardwood (M)	Jack pine 51%; 2nd major species hardwood
45	Softwood–Hardwood (M)	Jack pine 50% or less; 2nd major species red pine; 3rd major species hardwood
46	Softwood–Hardwood (M)	Jack pine 50% or less; 2nd major species red pine; 3rd major species hardwood

B. Continued

Subtype	Cover type	Species composition
08	Softwood (S)	Scots pine 71–100%
09	Softwood (S)	Scots pine 40–70%; 2nd major species jack pine
48	Softwood–Hardwood (H)	Scots pine 51%+; 2nd major species hardwood
49	Softwood–Hardwood (H)	Scots pine 50% or less; 2nd major species jack pine; 3rd major species hardwood
10	Softwood (S)	White spruce 71–100%
11	Softwood (S)	White spruce 40–70%; 2nd major species jack pine, balsam fir, or black spruce
50	Softwood–Hardwood (M)	White spruce 51%+; 2nd major species hardwood
51	Softwood–Hardwood (M)	White spruce 51% or less; 2nd major species balsam fir, jack pine, or black spruce
13	Softwood (S)	Black spruce 71–100%
14	Softwood (S)	Black spruce 40–70%; 2nd major species jack pine
15	Softwood (S)	Black spruce 40–70%; 2nd major species balsam fir, white spruce
16	Softwood (S)	Black spruce 40–70%; 2nd major species tamarack larch
17	Softwood (S)	Black spruce 40–70%; 2nd major species eastern cedar
53	Softwood–Hardwood (M)	Black spruce 51%+; 2nd major species hardwood
54	Softwood–Hardwood (M)	Black spruce 50% or less; 2nd major species jack pine; 3rd major species hardwood
55	Softwood–Hardwood (M)	Black spruce 50% or less; 2nd major species balsam fir; 3rd major species hardwood
56	Softwood–Hardwood (M)	Black spruce 50% or less; 2nd major species tamarack larch; 3rd species hardwood
57	Softwood–Hardwood (M)	Black spruce 50% or less; 2nd major species eastern cedar; 3rd major species hardwood
58	Softwood–Hardwood (M)	Black spruce 50% or less; 2nd major species white spruce; 3rd major species hardwood
20	Softwood (S)	Balsam fir 71–100%
21	Softwood (S)	Balsam fir 40–70%; 2nd major species spruce
22	Softwood (S)	Balsam fir 40–70%; 2nd major species eastern cedar
60	Softwood–Hardwood (M)	Balsam fir 51%+; 2nd major species hardwood
61	Softwood–Hardwood (M)	Balsam fir 50% or less; 2nd major species spruce; 3rd major species hardwood
62	Softwood–Hardwood (M)	Balsam fir 50% or less; 2nd major species eastern cedar; 3rd major species hardwood
30	Softwood (S)	Tamarack larch 71–100%

B. Continued

Subtype	Cover type	Species composition
31	Softwood (S)	Tamarack larch 40–70%; 2nd major species spruce
32	Softwood (S)	Tamarack larch 40–70%; 2nd major species eastern cedar
70	Softwood–Hardwood (M)	Tamarack larch 51%+; 2nd major species hardwood
71	Softwood–Hardwood (M)	Tamarack larch 50% or less; 2nd major species spruce; 3rd major species hardwood
72	Softwood–Hardwood (M)	Tamarack larch 50% or less; 2nd major species eastern cedar; 3rd major species hardwood
36	Softwood (S)	Eastern cedar 71–100%
37	Softwood (S)	Eastern cedar 40–70%
76	Softwood–Hardwood (M)	Eastern cedar 51%+; 2nd major species hardwood
77	Softwood–Hardwood (M)	Eastern cedar 50% or less; 2nd major species hardwood
90	Hardwood (H)	Trembling aspen
91	Hardwood (H)	Trembling aspen less than 5%; 2nd major species white birch (20%)
80	Hardwood–Softwood (N)	Trembling aspen; 2nd major species red pine
81	Hardwood–Softwood (N)	Trembling aspen; 2nd major species jack pine
82	Hardwood–Softwood (N)	Trembling aspen; 2nd major species spruce or balsam fir
98	Hardwood (H)	Balsam poplar
88	Hardwood–Softwood (N)	Balsam poplar; 2nd major species softwood
92	Hardwood (H)	White birch
85	Hardwood–Softwood (N)	White birch; 2nd major species red pine
86	Hardwood–Softwood (N)	White birch; 2nd major species jack pine
87	Hardwood–Softwood (N)	White birch; 2nd major species spruce or balsam fir
93	Hardwood (H)	Basswood
94	Hardwood (H)	Ash
95	Hardwood (H)	Elm
96	Hardwood (H)	Bur oak
97	Hardwood (H)	Manitoba maple
83	Hardwood–Softwood (N)	Hardwoods; 2nd major species pine
84	Hardwood–Softwood (N)	Hardwoods; 2nd major species spruce
99	Hardwood (H)	All hardwoods

B. Concluded

Subtype	Cover type	Species composition
9A	Hardwood (H)	Largetooth aspen
9B	Hardwood (H)	Eastern cottonwood
9C	Hardwood (H)	Hackberry
9D	Hardwood(H)	Hop hornbeam
9E	Hardwood (H)	Willow

C. Site Classification

Moisture regime	Landform	Indicator plants		Site class by species working group[a]					
		Abundant	Scattered	JP	WS	BF	BS	TL	TA
Arid	Rock outcrop, higher gravel beach ridges	Reindeer moss, creeping savin	Bearberry	2	3	–[b]	–	–	3
Dry	Higher beach, outwash and moraine ridges	Bearberry, creeping savin, reindeer moss, slender mountain rice	Common juniper, soapberry	2	3	3	3	–	2
Moist (groundwater and vadose water[c])	Low positions and flaring out margins on beach and outwash or till plains, lacustrine flats and higher flood plains	Red osier dogwood, bunchberry, *Ribes* sp., naked mitewort, creeping snowberry	Buffalo berry, common juniper, rough grained mountain rice, alder	1	1	1	1	–	1
Very moist	Depressional positions on beach and outwash and lacustrine deposits	Red osier dogwood, naked mitewort, bunchberry, *Ribes* sp., alder	Bog cranberry	1	1	1	1	1	1
Wet	Depressional positions on till and lucustrine materials	Alder, marsh marigold, bog cranberry		–	–	–	1	1	1
Saturated	Deep organic terrain	*Sphagnum* sp., labrador tea, marsh marigold		–	–	–	2	2	–

[a] JP = jack pine; WS = white spruce; BF = balsam fir; BS = black spruce; TL = tamarack larch; TA = trembling aspen. Note: Arid sites are generally devoid of tree cover.

[b] Dashes indicate not applicable.

[c] Vadose water is groundwater suspended or in circulation above the water table.

D. Crown Closure

Code	Description
0	0–20% crown closure
2	21–50% crown closure
3	51–70% crown closure
4	71% and over

E. Cutting Class

Cutting class is based on the size, vigor, state of development, and maturity of a stand for harvesting purposes.

Class	Description
0	Forest land not restocked following fire, cutting, windfall, or other major disturbances (hence, potentially productive land). Some reproduction or scattered residual trees (with net merchantable volume less than 20 m^3 per hectare) may be present.
1	Stands that have been restocked either naturally or artificially. There may be scattered residual trees present as in Cutting Class 0. To be in Cutting Class 1, the average height of the stand must be less than 3 m.
2	Advanced young growth of post size, with some merchantable volume. The average height of the stand must be greater than 3 m in order to be in this cutting class.
3	Immature stands with merchantable volume growing at or near their maximum rate, which definitely should not be cut. The average height of the stand should be greater than 10 m and the average diameter should be greater than 9.0 cm at a Dbh of 1.3 m.
4	Mature stands that may be cut as they have reached rotation age (±) 10 years on Site 1 or (±) 20 years on Site 2.
5	Overmature stands, which should be given priority in cutting.

F. Tree Species

Common name	Scientific name
Ash	*Fraxinus* sp.
Balsam fir	*Abies balsamea* (L.) Mill.
Balsam poplar	*Populus balsamifera* L.
Basswood	*Tilia americana* L.
Black spruce	*Picea mariana* (Mill.) BSP.
Eastern white cedar	*Thuja occidentalis* L.
Eastern cottonwood	*Populus deltoides* Bartr.
Eastern white pine	*Pinus strobus* L.
Elm	*Ulmus* sp.
Hackberry	*Celtis occidentalis* L.
Hop hornbeam	*Ostrya virginiana* (Mill.) K. Koch
Jack pine	*Pinus banksiana* Lamb.
Largetooth aspen	*Populus granditentata* Michx.
Manitoba maple	*Acer negundo* L.
Oak	*Quercus* sp.
Red pine	*Pinus resinosa* Ait.
Scots pine	*Pinus sylvestris* L.
Tamarack larch	*Larix laricina* (Du Roi) K. Koch
Trembling aspen	*Populus tremuloides* Michx.
White birch	*Betula papyrifera* Marsh.
White spruce	*Picea glauca* (Moench) Voss
Willow	*Salix* sp.

APPENDIX 2
HABITAT ASSOCIATIONS FOR VERTEBRATE SPECIES OF WILDLIFE FOUND IN THE BOREAL ECOZONES OF MANITOBA

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)					
	RJ	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
AMPHIBIANS																														
American toad	–[a]	R	F	–	F	–	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Blue-spotted salamander	–	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F	F	F	–	–	–	F	F	F	–	–	–
Boreal chorus frog	F	R	F	–	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Canadian toad	F	R	–	–	–	F	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cope's gray treefrog	F	R	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–
Gray treefrog	F	R	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–
Green frog	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Leopard frog	F	R	F	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mink frog	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern spring peeper	F	R	F	–	F	–	F	F	F	F	–	–	F	F	F	F	–	–	F	F	F	F	–	–	F	F	F	F	–	–
Wood frog	F	R	F	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–	F	F	–	–	–	–
BIRDS																														
Alder flycatcher	F	A	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American white pelican	A	F	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American bittern	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American black duck	–	A	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American coot	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American crow	F	–	–	–	A	[1]F	A	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–
American goldfinch	A	–	–	–	A	F	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American kestrel	F	–	–	–	F	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–
American redstart	FC	–	–	–	FC	–	FC	A	A	–	–	–	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American robin	–	–	–	–	–	F	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American tree sparrow	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American wigeon	–	A	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
American woodcock	–	–	–	–	A	–	A	A	A	–	–	–	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Baird's sparrow	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bald eagle	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	R	–	–	–	R	R	R	–	–	–
Barred owl	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)					
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Bay-breasted warbler	F	–	–	–	F	–	F	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Belted kingfisher	F	F	–	–	F	–	F	F	–	–	–	–	F	A	A	–	–	–	F	A	A	–	–	–	F	A	A	–	–	–
Black-and-white warbler	F	–	–	–	F	–	A	FC	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Black scoter	–	–	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Black tern	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Black-backed woodpecker	–	–	–	–	–	–	F	F	F	–	–	–	–	A	A	–	–	–	F	A	A	A	A	A	F	A	A	A	A	A
Black-billed cuckoo	A	–	–	–	A	F	A	A	A	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Black-billed magpie	F	–	–	–	F	F	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Black-capped chickadee	A	–	–	–	A	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	–	–	–	–	–	–
Black-crowned night heron	A	F	–	–	–	–	R	R	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Blackpoll warbler	–	–	–	–	A	–	–	A	A	A	–	–	–	A	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Black-throated green warbler	–	–	–	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Blackburnian warbler	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Blue jay	A	–	–	–	A	–	A	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Blue-winged teal	–	A	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bobolink	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bohemian waxwing	–	–	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–
Bonaparte's gull	–	–	A	A	–	F	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–
Boreal chickadee	–	–	–	–	–	–	–	–	–	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Boreal owl	–	F	–	–	F	–	F	F	F	F	F	F	F	A	A	A	A	A	F	A	A	A	A	A	F	A	A	A	A	A
Brewer's blackbird	A	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Broad-winged hawk	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Brown creeper	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–
Brown thrasher	–	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bufflehead	–	F	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	–	–	–	–	R	R	–	–	–	–
Burrowing owl	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
California gull	–	–	–	A	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Canada goose	–	A	A	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)					
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Canada warbler	A	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Canvasback	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cape May warbler	–	–	–	–	–	–	F	–	FC	FC	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Cedar waxwing	FC	–	–	F	FC	–	A	A	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–
Chestnut-sided warbler	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chipping sparrow	A	–	–	–	A	F	–	–	A	–	–	–	A	A	A	–	–	–	A	A	A	–	A	–	–	–	–	–	–	–
Clay-coloured sparrow	A	–	–	–	A	F	A	A	A	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Common goldeneye	–	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	–	–	–	–	R	R	–	–	–	–
Common grackle	–	–	–	–	–	F	–	–	A	–	–	–	–	–	A	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–
Common merganser	R	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	R	–	–	–	R	R	R	–	–	–
Common nighthawk	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Common raven	–	F	F	F	–	F	–	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Common redpoll	–	–	–	A	–	–	–	A	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Common snipe	–	A	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Common tern	–	–	–	A	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Common yellowthroat	FC	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Connecticut warbler	FC	A	A	–	A	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cooper's hawk	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Dark-eyed junco	CF	–	–	–	F	C	C	–	A	–	–	–	–	A	A	–	A	–	–	–	–	–	A	–	–	A	A	–	A	–
Dickcissel	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Double-crested cormorant	A	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Downy woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Eastern bluebird	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Eastern kingbird	A	A	–	–	A	F	A	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Eastern wood pewee	A	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
European starling	–	–	–	–	–	F	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Evening grosbeak	–	–	–	–	–	–	F	–	–	–	–	–	A	A	A	A	–	–	A	A	A	A	–	–	A	A	A	A	–	–
Field sparrow	–	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Forster's tern	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)					
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Fox sparrow	–	–	–	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Franklin's gull	–	A	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gadwall	–	A	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Golden eagle	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	–	–	–	–	R	R	–	–	–	–
Golden-crowned kinglet	–	–	A	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Golden-winged warbler	A	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gray catbird	A	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gray jay	–	F	–	–	–	–	–	–	A	–	–	–	–	–	A	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–
Gray partridge	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Great blue heron	A	F	F	R	–	F	–	–	–	–	–	–	–	–	–	–	–	–	R	R	R	–	–	–	R	R	R	–	–	–
Great crested flycatcher	A	–	–	–	F	–	F	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–
Great gray owl	–	F	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	A	–	A	A	A	A	A	–	A	A	A	A	A
Great horned owl	F	A	F	–	A	F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Greater yellowlegs	A	F	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Green-winged teal	–	A	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hairy woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Hermit thrush	F	–	–	–	F	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Herring gull	–	–	–	A	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hooded merganser	R	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	R	–	–	–	R	R	R	–	–	–
Horned grebe	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Horned lark	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
House wren	A	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Indigo bunting	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Killdeer	A	–	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Le Conte's sparrow	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Least flycatcher	F	–	–	–	A	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Lesser scaup	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lesser yellowlegs	A	F	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Lincoln's sparrow	A	A	–	–	A	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)					
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Loggerhead shrike	–	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Long-eared owl	A	F	–	–	A	F	A	A	A	A	A	A	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–
Magnolia warbler	FC	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mallard	A	A	–	–	–	F	–	–	–	–	–	–	R	–	–	–	–	–	R	–	–	–	–	–	R	–	–	–	–	–
Marbled godwit	–	A	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Marsh wren	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Merlin	A	A	A	A	F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Mountain bluebird	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Mourning dove	A	–	–	–	A	F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	–	–	–	A	A	A	–	–	–
Mourning warbler	A	A	–	–	A	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nashville warbler	–	–	A	A	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern cardinal	A	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern flicker	F	–	–	–	F	F	–	F	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Northern goshawk	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Northern harrier	–	A	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern hawk-owl	–	–	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Northern mockingbird	–	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern oriole	–	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Northern pintail	A	–	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern saw-whet owl	A	A	–	–	A	–	F	F	F	F	F	F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Northern shoveler	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern waterthrush	A	A	A	–	A	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Olive-sided flycatcher	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Orange-crowned warbler	FC	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Osprey	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	R	R	R	–	–	–	R	R	R	–	–	–
Ovenbird	F	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Palm warbler	FC	FC	FC	F	F	F	F	FC	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Philadelphia vireo	FC	–	–	–	A	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–
Pie-billed grebe	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Pileated woodpecker	F	–	–	–	F	–	F	F	F	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–
Pine grosbeak	–	–	–	–	F	–	F	A	A	–	–	–	F	F	A	A	–	–	F	F	–	–	–	–	F	F	–	–	–	–
Pine siskin	F	–	–	–	F	–	F	A	A	–	–	–	F	A	A	–	–	–	F	A	A	–	–	–	F	A	A	–	–	–
Purple finch	F	–	–	–	F	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–
Red crossbill	–	–	–	–	–	F	–	–	FC	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Red-breasted merganser	R	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Red-breasted nuthatch	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Red-eyed vireo	A	–	–	–	A	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–
Red-necked grebe	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Red-tailed hawk	F	–	–	–	F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Red-winged blackbird	FC	A	A	–	A	FC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ring-billed gull	–	–	–	A	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ring-necked duck	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rose-breasted grosbeak	–	–	–	–	–	–	A	A	–	–	–	–	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ruby-crowned kinglet	FC	–	A	–	FC	–	A	A	A	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Ruby-throated hummingbird	F	–	–	–	F	–	F	F	F	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Ruddy duck	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ruffed grouse	A	–	–	–	A	F	A	A	A	A	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Rusty blackbird	A	A	–	–	–	F	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sandhill crane	–	A	A	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Savannah sparrow	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sedge wren	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sharp-shinned hawk	–	–	–	–	F	–	F	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sharp-tailed grouse	F	–	A	–	A	A	A	A	A	A	A	A	A	A	A	–	–	–	A	A	A	–	–	–	A	–	–	–	–	–
Sharp-tailed sparrow	F	A	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Short-billed dowitcher	–	A	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Short-eared owl	–	A	A	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Solitary sandpiper	FC	F	A	–	–	–	–	A	A	A	A	A	–	A	A	A	A	A	–	A	A	A	A	A	–	A	A	A	A	A

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	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Solitary vireo	FC	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–
Song sparrow	A	F	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sora rail	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sprague's pipit	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Spruce grouse	A	A	–	–	F	–	–	A	A	A	A	A	–	A	A	A	A	A	–	A	A	A	A	A	–	A	A	A	A	A
Surf scoter	–	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Swainson's thrush	F	–	–	–	A	–	A	A	A	–	–	–	A	A	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–
Swamp sparrow	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tennessee warbler	–	A	–	–	A	–	–	A	A	–	–	–		A	A	A	–	–	–	A	A	A	–	–	A	A	A	–	–	–
Three-toed woodpecker	–	–	A	–	F	–	–	F	F	–	–	–	–	–	A	A	A	–	F	F	A	A	A	–	F	F	A	A	A	–
Tree swallow	A	F	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Turkey vulture	–	–	–	F	–	F	–	–	–	–	–	–	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Upland sandpiper	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Veery	A	–	–	–	A	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Vesper sparrow	–	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Virginia rail	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Warbling vireo	A	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Western grebe	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Western kingbird	–	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Western meadowlark	–	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Western wood pewee	A	–	–	–	A	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Whip-poor-will	A	–	–	–	A	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
White-breasted nuthatch	A	–	–	–	A	–	F	F	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–
White-throated sparrow	C	–	–	–	FC	F	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–
White-winged crossbill	–	–	–	–	–	F	–	–	FC	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
White-winged scoter	–	F	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wild turkey	F	–	–	–	A	F	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–
Wilson's phalarope	–	A	–	–	–	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wilson's warbler	FC	–	–	–	A	–	A	FC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Winter wren	A	–	–	–	FC	–	–	–	–	–	–	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	A	A	–	–
Wood duck	A	F	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wood thrush	–	–	–	–	A	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yellow rail	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yellow warbler	A	–	–	–	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yellow-bellied flycatcher	A	–	–	–	A	–	–	A	A	A	–	–	–	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–
Yellow-bellied sapsucker	–	–	–	–	–	–	F	F	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Yellow-headed blackbird	–	A	–	–	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yellow-rumped warbler	F	F	F	F	F	F	F	FC	A	A	A	A	F	A	A	A	A	A	F	A	A	A	A	A	F	A	A	A	A	A
Yellow-throated vireo	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
MAMMALS																														
Arctic shrew	A	A	A	–	A	FC	–	–	–	A	–	A	–	–	–	A	–	A	–	–	–	A	–	A	–	–	–	A	–	A
Beaver	A	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Big brown bat	F	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Black bear	A	A	–	A	–	F	FC	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Coloured fox	A	FC	FC	A	FC	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Coyote	A	–	–	A	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Deer mouse	A	–	–	A	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Elk	F	–	–	–	–	FR	FR	FC	–	–	–	–	CR	CR	–	–	–	–	CR	R	–	–	–	–	CR	R	–	–	–	–
Ermine	A	FC	FC	A	FC	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Fisher	A	–	FC	FC	FC	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Heather vole	–	–	A	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hoary bat	A	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Keen's myotis	F	–	F	F	–	–	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	–
Least chipmunk	A	–	–	A	–	A	FC	FC	FC	FC	FC	FC	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Little brown bat	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	A	–	A	A	A	–	A	–
Lynx	A	–	FC	FC	–	–	FC	FC	FC	FC	FC	–	FC	FC	FC	FC	FC	FC	–	–	–	–	–	–	–	–	–	–	–	–
Marten	A	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–	A	A	A	–
Masked shrew	A	A	A	–	A	FC	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)					
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Meadow jumping mouse	A	A	A	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Meadow vole	A	A	A	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mink	A	A	A	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Moose	A	FU	–	–	A	–	F	F	FC	–	–	–	A	A	C	–	–	–	A	C	C	–	–	–	C	C	–	–	–	–
Muskrat	–	A	–	–	C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern bog lemming	–	A	A	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A
Northern flying squirrel	A	–	–	–	F	–	–	–	–	–	–	–	–	F	F	F	F	F	A	A	A	A	A	A	A	A	A	A	A	A
Otter	A	FC	FC	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Porcupine	A	–	F	F	–	–	–	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Pygmy shrew	A	A	A	–	A	A	–	–	A	A	–	A	–	–	A	A	–	A	–	–	A	A	–	A	–	–	A	A	–	A
Racoon	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–
Red squirrel	A	–	FC	FC	–	–	–	–	C	C	C	–	–	–	FC	FC	FC	–	–	–	A	A	A	–	–	–	A	A	A	–
Silver-haired bat	A	F	F	F	F	–	–	–	–	–	–	–	–	A	A	A	A	A	–	A	A	A	A	A	–	A	A	A	A	A
Southern bog lemming	–	A	A	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A	–	–	–	–	–	A
Southern red-backed vole	–	–	–	–	A	F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Star-nosed mole	A	A	FC	–	FC	FC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Striped skunk	A	–	–	A	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Water shrew	A	A	FC	–	A	FC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
White-tailed deer	–	–	–	–	A	A	A	A	A	–	–	–	A	A	–	–	–	–	–	–	C	–	–	–	–	–	–	–	–	–
Wolf	–	–	–	–	F	–	A	A	A	–	–	–	A	A	–	–	–	–	A	A	A	–	–	–	A	A	A	–	–	–
Wolverine	F	F	F	F	F	–	–	–	–	–	–	–	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Woodchuk	A	–	–	FC	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Woodland caribou	–	F	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	–	A	A	A	A	A
Woodland jumping mouse	–	–	–	–	–	A	A	A	A	–	–	–	A	A	A	A	–	A	A	A	A	A	–	–	A	A	A	A	–	–
REPTILES																														
Common snapping turtle	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern redbelly snake	A	–	–	–	–	A	A	A	–	–	–	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Red-sided garter snake	F	F	–	C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Species	Non-commercial forested land					Stands at shrubs–seedling stage (<10 years old)							Stands at pole–sapling stage (11–39 years old)						Stands at intermediate stage (40–69 years old)						Stands at mature to overmature stage (70+ years old)					
	RI	MB	TM	TR	WA	GF	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL	H	DM	CM	SSP	SJP	SL
Western painted turtle	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Western plains garter snake	F	F	–	–	–	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

[a] Dashes indicate the species has no association with the habitat type for its life requisites.

Note: RI = riparian; MB = marsh–bog; TM = treed muskeg; TR = treed rock; WA = willow–alder; GF = grass–forbs; H = hardwoods; DM = deciduous-dominated mixedwoods; CM = coniferous-dominated mixedwood; SSP = softwood spruce; SJP = softwood jack pine; SL = softwood larch; R = reproduction; F = feeding; C = cover; A = provides all life requisites; U = provides for unique requirements.

APPENDIX 3
WILDLIFE SPECIES LIST FOR MANITOBA'S BOREAL PLAINS AND BOREAL SHIELD ECOZONES

Species common name	Species scientific name	Ecozone
	AMPHIBIANS	
American toad	*Bufo americanus*	Both
Blue-spotted salamander	*Ambystoma laterale*	Shield
Boreal chorus frog	*Pseudacris triseriata maculata*	Both
Canadian toad	*Bufo hemiophrys*	Both
Cope's gray treefrog	*Hyla chrysoscelis*	Plains
Gray treefrog	*Hyla versicolor*	Both
Green frog	*Rana clamitans melanota*	Shield
Leopard frog	*Rana pipiens*	Both
Mink frog	*Rana septentrionalis*	Shield
Northern spring peeper	*Pseudacris crucifer crucifer*	Shield
Wood frog	*Rana sylvatica*	Both
	REPTILES	
Common snapping turtle	*Chelydra serpentina serpentina*	Both
Northern redbelly snake	*Storeria occipitomaculata*	Both
Red-sided garter snake	*Thamnophis sirtalis parietalis*	Both
Western painted turtle	*Chrysemys picta belli*	Both
Western plains garter snake	*Thamnophis radix haydeni*	Plains
	BIRDS	
***Podicipediformes*: Grebes**		
Horned grebe	*Podiceps auritus*	Both
Pie-billed grebe	*Podilymbus podiceps*	Both
Red-necked grebe	*Podiceps grisegena*	Both
Western grebe	*Aechmophorus occidentalis*	Plains
***Pelecaniformes*: Pelican, Cormorants**		
American white pelican	*Pelecanus erythrorhynchos*	Plains
Double-crested cormorant	*Phalacrocorax auritus*	Plains
***Ciconiformes*: Heron, Ibises, and Storks**		
American bittern	*Botaurus lentiginosus*	Both
Black-crowned night heron	*Nycticorax nycticorax*	Plains
Great blue heron	*Ardea herodias*	Both
***Anseriformes*: Waterfowl**		
American black duck	*Anas rubripes*	Plains
American widgeon	*Anas americana*	Both
Black scoter	*Melanitta nigra*	Shield
Blue-winged teal	*Anas discors*	Both
Bufflehead	*Bucephala albeola*	Both

Species common name	Species scientific name	Ecozone
Canada goose	*Branta canadensis*	Both
Canvasback	*Aythya valisineria*	Plains
Common goldeneye	*Bucephala clangula*	Both
Common merganser	*Mergus merganser*	Both
Gadwall	*Anas strepera*	Plains
Green-winged teal	*Anas crecca*	Both
Hooded merganser	*Lophodytes cucullatus*	Both
Lesser scaup	*Aythya affinis*	Both
Mallard	*Anas platyrhynchos*	Both
Northern pintail	*Anas acuta*	Both
Northern shoveler	*Anas clypeata*	Both
Red-breasted merganser	*Mergus serrator*	Both
Ring-necked duck	*Aythya collaris*	Both
Ruddy duck	*Oxyura jamaicensis*	Plains
Surf scoter	*Melanitta perspicillata*	Shield
White-winged scoter	*Melanitta deglandi*	Both
Wood duck	*Aix sponsa*	Plains
***Falconiformes*: Diurnal Birds of Prey**		
American kestrel	*Falco sparverius*	Both
Bald eagle	*Haliaeetus leucocephalus*	Both
Broad-winged hawk	*Buteo platypterus*	Plains
Cooper's hawk	*Accipiter cooperii*	Both
Golden eagle	*Aquila chrysaetos*	Shield
Merlin	*Falco columbarius*	Both
Northern goshawk	*Accipiter gentilis*	Both
Northern harrier	*Circus cyaneus*	Both
Osprey	*Pandion haliateus*	Both
Red-tailed hawk	*Buteo jamaicensis*	Both
Sharp-shinned hawk	*Accipiter striatus*	Both
Turkey vulture	*Cathartes aura*	Plains
***Galliformes*: Pheasants, Grouse**		
Gray partridge	*Perdix perdix*	Plains
Ruffed grouse	*Bonasa umbellus*	Both
Sharp-tailed grouse	*Tympanuchus phasianellus*	Both
Spruce grouse	*Dendragapus canadensis*	Both
***Meleagrididae*: Turkeys**		
Wild turkey	*Meleagris gallopavo*	Plains
***Gruiformes*: Rails, Cranes**		
American coot	*Fulica americana*	Both
Sora rail	*Porzana carolina*	Both
Sandhill crane	*Grus canadensis*	Both
Virginia rail	*Rallus limicola*	Both
Yellow rail	*Coturnicops noveboracensis*	Both

Species common name	Species scientific name	Ecozone
***Charadriiformes*: Shorebirds, Gulls**		
Black tern	*Chilidonias niger*	Both
Bonaparte's gull	*Larus philadelphia*	Both
California gull	*Larus californicus*	Plains
Common tern	*Sterna hirundo*	Both
Forster's tern	*Sterna forsteri*	Plains
Franklin's gull	*Larus pipixcan*	Plains
Herring gull	*Larus argentatus*	Both
Killdeer	*Charadrius vociferus*	Both
Ring-billed gull	*Larus delewarensis*	Both
***Scolopacidae*: Woodcock, Snipe, Sandpipers**		
American woodcock	*Philohela minor*	Plains
Greater yellowlegs	*Totanus melanoleucus*	Both
Lesser yellowlegs	*Totanus flavipes*	Both
Short-billed dowitcher	*Limnodromus griseus*	Shield
Marbled godwit	*Limos fedoa*	Plains
Common snipe	*Capella gallinago*	Both
Solitary sandpiper	*Tringa solitaria*	Both
Upland sandpiper	*Bartramia longicauda*	Plains
Wilson's phalarope	*Phalaropus tricolor*	Plains
***Columbiformes*: Pigeons, Doves**		
Mourning dove	*Zenaida macroura*	Plains
***Strigiformes*: Owls**		
Barred owl	*Strix varia*	Shield
Boreal owl	*Aegolius funereus*	Both
Burrowing owl	*Speotyto cunicularia*	Plains
Great gray owl	*Strix nebulosa*	Shield
Great horned owl	*Bubo virginianus*	Both
Long-eared owl	*Asio otus*	Shield
Northern hawk-owl	*Surnia ulula*	Both
Northern saw-whet owl	*Aegolius acadicus*	Plains
Short-eared owl	*Asio flammeus*	Both
***Caprimulgiformes*: Goatsuckers**		
Common nighthawk	*Chordeiles minor*	Both
Whip-poor-will	*Caprimulgus vociferus*	Plains
***Apodiformes*: Hummingbirds**		
Ruby-throated hummingbird	*Archilochus colubris*	Plains
***Coraciiformes*: Kingfishers**		
Belted kingfisher	*Ceryle alcyon*	Plains
***Piciformes*: Woodpeckers and Allies**		
Black-backed woodpecker	*Picoides arcticus*	Both
Downy woodpecker	*Picoides pubescens*	Both

Species common name	Species scientific name	Ecozone
Hairy woodpecker	*Picoides villosus*	Both
Northern flicker	*Colaptes auratus*	Both
Pileated woodpecker	*Dryocopus pileatus*	Both
Three-toed woodpecker	*Picoides tridactylus*	Both
Yellow-bellied sapsucker	*Sphyrapicus varius*	Both
Brown creeper	*Certhia familiaris*	Plains
Red-breasted nuthatch	*Sitta canadensis*	Both
White-breasted nuthatch	*Sitta carolinensis*	Plains
***Passeriformes*: Perching Birds**		
Alder flycatcher	*Empidonax alnorum*	Both
American crow	*Corvus brachyrhynchos*	Both
American goldfinch	*Carduelis tristis*	Plains
American redstart	*Setophaga ruticilla*	Both
American robin	*Turdus migratorius*	Both
American tree sparrow	*Spizella arborea*	Shield
Baird's sparrow	*Ammodramus bairdii*	Plains
Bay-breasted warbler	*Dendroica castanea*	Both
Black-and-white warbler	*Mniotilta varia*	Both
Black-billed cuckoo	*Coccyzus erythropthalmus*	Plains
Black-billed magpie	*Pica pica*	Both
Black-capped chickadee	*Parus atricapillus*	Both
Blackpoll warbler	*Dendroica striata*	Both
Black-throated green warbler	*Dendroica virens*	Plains
Blackburnian warbler	*Dendroica fusca*	Plains
Blue jay	*Cyanocitta cristata*	Both
Bobolink	*Dolichonyx oryzivorus*	Plains
Bohemian waxwing	*Bombycilla garrulus*	Shield
Boreal chickadee	*Parus hudsonicus*	Both
Brewer's blackbird	*Euphagus cyanocephalus*	Plains
Brown thrasher	*Toxostoma rufum*	Plains
Canada warbler	*Wilsonia canadensis*	Plains
Cape May warbler	*Dendroica tigrina*	Both
Cedar waxwing	*Bombycilla cedrorum*	Both
Chestnut-sided warbler	*Dendroica pensylvanica*	Plains
Chipping sparrow	*Spizella passerina*	Both
Clay-coloured sparrow	*Spizella pallida*	Plains
Common grackle	*Quiscalus quiscula*	Shield
Common raven	*Corvus corax*	Both
Common redpoll	*Cardeulis flammea*	Shield
Common yellowthroat	*Geothylpis trichas*	Both
Connecticut warbler	*Oporornis agilis*	Both
Dark-eyed junco	*Junco hyemalis*	Both
Dickcissel	*Spiza americana*	Plains
Eastern bluebird	*Sialia sialis*	Plains
Eastern kingbird	*Tyrannus tyrannus*	Both
Eastern wood pewee	*Contopus virens*	Plains

Species common name	Species scientific name	Ecozone
European starling	*Sturnus vulgaris*	Both
Evening grosbeak	*Coccothraustes vespertinus*	Plains
Field sparrow	*Spizella pusilla*	Plains
Fox sparrow	*Passerella iliaca*	Shield
Golden-crowned kinglet	*Regulus satrapa*	Both
Golden-winged warbler	*Vermivora chrysoptera*	Plains
Gray catbird	*Dumetella carolinensis*	Plains
Gray jay	*Perisoreus canadensis*	Both
Great crested flycatcher	*Myiarchus crinitus*	Plains
Hermit thrush	*Catharus guttatus*	Plains
Horned lark	*Eremophila alpestris*	Both
House wren	*Troglodytes aedon*	Plains
Indigo bunting	*Passerina cyanea*	Plains
Le Conte's sparrow	*Ammodramus leconteii*	Both
Least flycatcher	*Empidonax minimus*	Both
Lincoln's sparrow	*Melospiza lincolnii*	Both
Loggerhead shrike	*Lanius ludovicianus*	Plains
Magnolia warbler	*Dendroica magnolia*	Both
Marsh wren	*Cistothorus palustris*	Plains
Mountain bluebird	*Sialia curruccoides*	Plains
Mourning warbler	*Oporornis philadelphia*	Plains
Nashville warbler	*Vermivora ruficapilla*	Both
Northern cardinal	*Cardinalis cardinalis*	Plains
Northern mockingbird	*Mimus polyglottos*	Plains
Northern oriole	*Icterus galbula*	Plains
Northern waterthrush	*Seiurus noveboracensis*	Both
Olive-sided flycatcher	*Contopus borealis*	Both
Orange-crowned warbler	*Vermivora celata*	Both
Ovenbird	*Seiurus aurocapillus*	Both
Palm warbler	*Dendroica palmarum*	Both
Philadelphia vireo	*Vireo philadelphicus*	Plains
Pine grosbeack	*Pinicola enucleator*	Both
Pine siskin	*Carduelis pinus*	Plains
Purple finch	*Carpodacus purpureus*	Plains
Red crossbill	*Loxia curviostra*	Both
Red-eyed vireo	*Vireo olivaceus*	Plains
Red-winged blackbird	*Agelaius phoeniceus*	Both
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Plains
Ruby-crowned kinglet	*Regulus calendula*	Both
Rusty blackbird	*Euphagus carolinus*	Both
Savannah sparrow	*Passerculus sandwichensis*	Both
Sedge wren	*Cistothorus platensis*	Plains
Sharp-tailed sparrow	*Ammodramus caudacuta*	Plains
Solitary vireo	*Vireo solitarius*	Both
Song sparrow	*Melospiza melodia*	Both
Sprague's pipit	*Anthus spraguenii*	Plains
Swainson's thrush	*Catharus ustulatus*	Both

Species common name	Species scientific name	Ecozone
Swamp sparrow	*Melospiza georgiana*	Both
Tennessee warbler	*Vermivora peregrina*	Both
Tree swallow	*Tachycineta bicolor*	Both
Veery	*Catharus fuscescens*	Plains
Vesper sparrow	*Pooecetes gramineus*	Both
Warbling vireo	*Vireo gilvus*	Plains
Western kingbird	*Tyrannus verticalis*	Plains
Western meadowlark	*Sturnella neglecta*	Plains
Western wood pewee	*Contopus sordidulus*	Plains
White-throated sparrow	*Zonotrichia albicollis*	Both
White-winged crossbill	*Loxia leucoptera*	Both
Wilson's warbler	*Wilsonia pusilla*	Both
Winter wren	*Troglodytes troglodytes*	Plains
Wood thrush	*Hylocichla mustelina*	Plains
Yellow warbler	*Dendroica petechia*	Both
Yellow-bellied flycatcher	*Empidonax flaviventris*	Both
Yellow-headed blackbird	*Xanthocephaleus xanthocephaleus*	Plains
Yellow-rumped warbler	*Dendroica coronata*	Both
Yellow-throated vireo	*Vireo flavifrons*	Plains
	MAMMALS	
***Soricidae*: Shrews**		
Arctic shrew	*Sorex arcticus*	Shield
Masked shrew	*Sorex cinereus*	Both
Pygmy shrew	*Sorex hoyi*	Both
Water shrew	*Sorex palustris*	Both
***Talidae*: Moles**		
Star-nosed mole	*Condylura cristata*	Both
***Chirptera*: Bats**		
Big brown bat	*Eptesicus fuscus*	Both
Hoary bat	*Lasiurus cinereus*	Both
Keen's myotis	*Myotis keenii*	Both
Little brown bat	*Myotis lucifugus*	Both
Silver-haired bat	*Lasionycteris noctivagans*	Both
***Carnivora*: Carnivores**		
Black bear	*Ursus americanus*	Both
Coloured fox	*Vulpes vulpes*	Both
Coyote	*Canis latrans*	Both
Ermine	*Mustela erminea*	Both
Fisher	*Martes pennanti*	Both
Lynx	*Lynx canadensis*	Both
Marten	*Martes americana*	Both
Mink	*Mustela vison*	Both
Otter	*Lutra canadensis*	Both
Raccoon	*Procyon lotor*	Plains

Species common name	Species scientific name	Ecozone
Striped skunk	*Mephitis mephitis*	Plains
Wolf	*Canis lupus*	Both
Wolverine	*Gulo gulo*	Shield
***Articodactyla*: Ungulates**		
Elk	*Cervus elaphus*	Plains
Moose	*Alces alces*	Both
White-tailed deer	*Odocoileus virginianus*	Both
Woodland caribou	*Rangifer tarandus*	Shield
***Rodentia*: Rodents**		
Beaver	*Castor canadensis*	Both
Deer mouse	*Peromyscus maniculatus*	Both
Heather vole	*Phenacomys intermedius*	Both
Least chipmunk	*Eutamias minimus*	Both
Meadow jumping mouse	*Zapus hudsonius*	Both
Meadow vole	*Microtus pennsylvanicus*	Both
Muskrat	*Ondatra zebethicus*	Both
Northern bog lemming	*Synaptomys borealis*	Both
Northern flying squirrel	*Glaucomys sabrinus*	Both
Porcupine	*Erethizon dorsatum*	Both
Red squirrel	*Tamiasciurus hudsonicus*	Both
Southern bog lemming	*Synaptomys cooperi*	Both
Southern red-backed vole	*Clethrionomys gapperi*	Both
Woodchuck	*Marmota monax*	Both
Woodland jumping mouse	*Napaeozapus insignis*	Both

APPENDIX 4
MERIT EVALUATION SCORES BY MERIT CATEGORY AND SUB-CATEGORY FOR THE 137 SPECIES CONSIDERED FOR MODELING

Species	Status	Ecology			Economic/cultural importance		Knowledge			Sensitivity to impact	Total Merit Evaluation Score
		Period of occurrence	Population concentration	Importance in ecosystem	Harvest	Cultural/ aesthetic	Model development	Monitoring	Distribution		
Alder flycatcher	2	1	1	1	0	1	0	1	1	1	9
American crow	2	1	1	2	0	3	2	1	2	1	15
American kestrel	2	1	0	1	0	3	0	0	2	5	14
American redstart	2	1	1	1	0	0	0	1	1	1	9
American robin	2	1	1	1	0	5	0	1	2	1	14
American toad	2	3	2	1	1	1	1	0	1	1	13
American tree sparrow	2	1	1	1	0	1	0	1	1	1	9
Arctic shrew	2	2	0	1	0	0	0	1	1	1	8
Bald eagle	3	1	1	1	0	5	4	2	3	5	25
Barred owl	2	2	0	1	0	3	0	0	1	5	14
Bay-breasted warbler	2	1	1	1	0	1	0	1	1	1	9
Beaver	0	2	2	3	5	3	4	1	3	1	24
Belted kingfisher	2	1	1	1	0	3	4	1	1	1	15
Black-and-white warbler	2	1	1	1	0	1	0	1	1	1	9
Black bear	2	2	0	1	3	5	4	0	3	1	21
Black-backed woodpecker	2	2	0	2	0	3	0	1	2	5	17
Black-billed magpie	2	2	0	2	0	1	0	1	1	1	10
Black-capped chickadee	2	2	0	1	0	3	4	1	1	1	15
Black-crowned night heron	2	1	1	1	0	1	0	1	1	1	9
Blackpoll warbler	2	1	1	1	0	1	0	1	1	1	9
Black-throated green warbler	2	1	1	1	0	1	0	1	1	1	9
Blackburnian warbler	2	1	1	1	0	1	0	1	1	1	9
Blue jay	2	2	0	1	0	3	0	1	1	1	11
Blue-spotted salamander	2	3	2	1	0	0	1	0	1	10	21
Bonaparte's gull	2	1	2	1	0	1	0	1	1	5	14
Boreal chickadee	2	2	0	1	0	1	0	1	1	5	13
Boreal owl	2	2	0	1	0	3	0	1	1	5	15
Broad-winged hawk	2	1	0	1	0	3	0	1	1	1	10
Brown creeper	2	1	1	1	0	1	0	1	1	5	13

Species	Status	Ecology			Economic/cultural importance		Knowledge			Sensitivity to impact	Total Merit Evaluation Score
		Period of occurrence	Population concentration	Importance in ecosystem	Harvest	Cultural/ aesthetic	Model development	Monitoring	Distribution		
Bufflehead	2	1	1	1	2	3	2	3	2	5	22
Canada warbler	2	1	1	1	0	1	0	1	1	1	9
Canadian toad	2	3	2	1	1	1	1	0	1	1	13
Cape May warbler	2	1	1	1	0	1	0	1	1	1	9
Cedar waxwing	2	2	1	1	0	1	0	1	2	1	11
Chestnut-sided warbler	2	1	1	1	0	1	0	1	1	1	9
Chipping sparrow	2	1	1	1	0	1	0	1	1	1	9
Common goldeneye	2	1	1	1	2	3	2	3	2	5	22
Common merganser	2	1	1	1	0	3	2	3	2	5	20
Common nighthawk	2	1	1	1	0	1	0	1	2	1	10
Common raven	2	2	1	2	0	5	2	1	2	1	18
Common redpoll	2	1	1	1	0	1	0	1	1	1	9
Common yellowthroat	2	1	1	1	0	1	0	1	1	1	9
Connecticut warbler	2	1	1	1	0	1	0	1	1	1	9
Cooper's hawk	8	1	0	1	0	3	0	0	1	5	19
Cope's gray treefrog	2	3	2	1	1	1	1	1	1	5	18
Dark-eyed junco	2	1	1	1	0	1	0	1	1	1	9
Deer mouse	2	2	0	1	0	0	0	1	1	1	8
Downy woodpecker	2	2	0	2	0	3	4	1	2	5	21
Eastern kingbird	2	1	1	1	0	1	0	1	1	1	9
Eastern wood pewee	2	1	1	1	0	1	0	1	1	1	9
Elk	2	2	2	1	5	3	3	3	3	1	25
Evening grosbeak	2	2	1	1	0	3	0	1	1	1	12
Fisher	2	2	0	1	5	1	4	1	2	5	23
Fox sparrow	2	1	1	1	0	1	0	1	1	1	9
Golden-crowned kinglet	2	1	1	1	0	1	0	1	1	5	13
Golden-winged warbler	2	1	1	1	0	1	0	1	1	1	9
Gray jay	2	2	0	1	0	3	0	1	2	1	12
Gray treefrog	2	3	2	1	1	1	1	1	1	5	18
Great blue heron	2	1	1	1	0	3	4	2	2	5	21

Species	Status	Ecology			Economic/cultural importance		Knowledge			Sensitivity to impact	Total Merit Evaluation Score
		Period of occurrence	Population concentration	Importance in ecosystem	Harvest	Cultural/ aesthetic	Model development	Monitoring	Distribution		
Great crested flycatcher	2	1	1	1	0	1	0	1	1	1	9
Great gray owl	8	2	0	1	0	5	3	3	2	5	29
Great horned owl	2	2	0	1	0	3	0	1	2	1	12
Hairy woodpecker	2	2	0	2	0	3	4	1	2	5	21
Heather vole	2	2	0	1	0	0	0	1	1	1	8
Hermit thrush	2	1	1	1	0	1	0	1	1	1	9
Hooded merganser	2	1	1	1	0	3	2	3	2	5	20
Indigo bunting	2	1	1	1	0	1	0	1	1	1	9
Least flycather	2	1	1	1	0	1	0	1	1	1	9
Lincoln's sparrow	2	1	1	1	0	1	0	1	1	1	9
Little brown bat	2	2	1	1	0	0	0	1	1	5	13
Long-eared owl	2	1	0	1	0	3	0	1	1	1	10
Lynx	3	2	0	1	4	1	2	1	2	1	17
Magnolia warbler	2	1	1	1	0	1	0	1	1	1	9
Marten	1	2	0	1	5	1	4	1	2	10	27
Meadow vole	2	2	0	1	0	0	0	1	1	1	8
Mink	2	2	0	1	5	1	4	1	3	1	20
Moose	4	2	1	1	5	5	4	3	3	5	33
Mourning dove	2	1	1	1	0	3	0	1	1	1	11
Mourning warbler	2	1	1	1	0	1	0	1	1	1	9
Nashville warbler	2	1	1	1	0	1	0	1	1	1	9
Northern bog lemming	2	2	0	1	0	0	0	1	1	1	8
Northern flicker	2	1	1	2	0	3	0	1	2	5	17
Northern goshawk	2	2	0	1	0	3	0	0	2	5	15
Northern hawk- owl	8	2	0	1	0	3	0	0	1	5	20
Northern redbelly snake	2	3	2	1	1	5	1	0	1	5	21
Northern saw-whet owl	2	2	0	1	0	3	0	1	1	1	11
Northern spring peeper	2	3	2	1	1	1	1	1	1	1	14
Northern waterthrush	2	1	1	1	0	1	0	1	1	1	9
Olive-sided flycatcher	2	1	1	1	0	1	0	1	1	1	9

Species	Status	Ecology			Economic/cultural importance		Knowledge			Sensitivity to impact	Total Merit Evaluation Score
		Period of occurrence	Population concentration	Importance in ecosystem	Harvest	Cultural/ aesthetic	Model development	Monitoring	Distribution		
Orange-crowned warbler	2	1	1	1	0	1	0	1	1	1	9
Osprey	2	1	0	1	0	3	4	1	1	5	18
Ovenbird	2	1	1	1	0	1	4	1	1	5	17
Palm warbler	2	1	1	1	0	1	0	1	1	1	9
Philadelphia vireo	2	1	1	1	0	1	0	1	1	1	9
Pileated woodpecker	2	2	0	2	0	3	4	1	3	10	27
Pine grosbeak	2	2	1	1	0	3	0	1	1	1	12
Pine siskin	2	1	1	1	0	1	0	1	1	1	9
Porcupine	2	2	0	1	0	1	0	0	2	1	9
Purple finch	2	1	1	1	0	1	0	1	1	1	9
Pygmy shrew	2	2	0	1	0	0	0	1	1	1	8
Red crossbill	2	1	1	1	0	1	0	1	1	1	9
Red squirrel	0	2	0	2	3	3	4	1	3	10	28
Red-breasted nuthatch	2	2	0	1	0	1	0	1	1	5	13
Red-eyed vireo	2	1	1	1	0	1	0	1	1	1	9
Rose-breasted grosbeak	2	1	1	1	0	1	0	1	1	1	9
Ruby-crowned kinglet	2	1	1	1	0	1	0	1	1	1	9
Ruby-throated hummingbird	2	1	1	1	0	1	0	1	1	1	9
Ruffed grouse	2	2	0	1	4	3	4	1	3	1	21
Sharp-shinned hawk	2	1	0	1	0	3	0	1	1	1	10
Sharp-tailed grouse	0	2	1	1	4	3	4	1	3	1	21
Solitary vireo	2	1	1	1	0	1	0	1	1	5	13
Southern bog lemming	2	2	0	1	0	0	0	1	1	1	8
Southern red-backed vole	2	2	0	2	0	0	4	1	1	1	13
Spruce grouse	2	2	0	1	2	3	0	1	2	1	14
Swainson's thrush	2	1	1	1	0	1	0	1	1	1	9
Tennessee warbler	2	1	1	1	0	1	0	1	1	1	9
Three-toed woodpecker	2	2	0	2	0	3	0	1	2	5	17
Tree swallow	2	1	1	1	0	1	0	1	1	1	9
Veery	2	1	1	1	0	1	4	1	1	1	13

Species	Status	Ecology			Economic/cultural importance		Knowledge			Sensitivity to impact	Total Merit Evaluation Score
		Period of occurrence	Population concentration	Importance in ecosystem	Harvest	Cultural/ aesthetic	Model development	Monitoring	Distribution		
Western kingbird	2	1	1	1	0	1	0	1	1	1	9
Western wood pewee	2	1	1	1	0	1	0	1	1	1	9
Whip-poor-will	2	1	1	1	0	3	0	1	1	1	11
White-breasted nuthatch	2	2	0	1	0	1	0	1	1	1	9
White-tailed deer	0	2	1	1	5	3	3	3	3	5	26
White-throated sparrow	2	1	1	1	0	1	0	1	1	1	9
White-winged crossbill	2	1	1	1	0	1	0	1	1	1	9
Wilson's warbler	2	1	1	1	0	1	0	1	1	1	9
Winter wren	2	1	1	1	0	1	0	1	1	1	9
Wolf	1	2	2	1	3	5	3	1	2	1	21
Wolverine	8	2	0	1	3	0	0	0	1	1	16
Wood duck	1	1	1	1	2	3	2	1	2	5	19
Wood frog	2	3	2	1	1	1	1	1	1	5	18
Woodland caribou	8	2	1	1	2	5	4	2	2	10	37
Woodland jumping mouse	2	2	0	1	0	0	0	1	1	1	8
Yellow warbler	2	1	1	1	0	1	0	1	1	1	9
Yellow-bellied flycatcher	2	1	1	1	0	1	0	1	1	1	9
Yellow-bellied sapsucker	2	1	0	2	0	3	0	1	2	5	16

APPENDIX 5
RANKED MERIT EVALUATION SCORES FOR 137 SPECIES CONSIDERED FOR MODELING

Woodland caribou	37	American robin	14	Eastern kingbird	9
Moose	33	Barred owl	14	Eastern wood pewee	9
Great gray owl	29	Bonaparte's gull	14	Fox sparrow	9
Red squirrel	28	Northern spring peeper	14	Golden-winged warbler	9
Marten	27	Spruce grouse	14	Great crested flycatcher	9
Pileated woodpecker	27	American toad	13	Hermit thrush	9
White-tailed deer	26	Brown creeper	13	Indigo bunting	9
Bald eagle	25	Boreal chickadee	13	Least flycatcher	9
Elk	25	Canadian toad	13	Lincoln's sparrow	9
Beaver	24	Golden-crowned kinglet	13	Magnolia warbler	9
Fisher	23	Little brown bat	13	Mourning warbler	9
Bufflehead	22	Red-breasted nuthatch	13	Nashville warbler	9
Common goldeneye	22	Solitary vireo	13	Northern waterthrush	9
Black bear	21	Southern red-backed vole	13	Olive-sided flycatcher	9
Blue-spotted salamander	21	Veery	13	Orange-crowned warbler	9
Downy woodpecker	21	Evening grosbeak	12	Palm warbler	9
Great blue heron	21	Gray jay	12	Philadelphia vireo	9
Hairy woodpecker	21	Great horned owl	12	Red-eyed vireo	9
Northern redbelly snake	21	Pine grosbeak	12	Rose-breasted grosbeak	9
Ruffed grouse	21	Blue jay	11	Tennessee warbler	9
Sharp-tailed grouse	21	Cedar waxwing	11	Western wood pewee	9
Wolf	21	Mourning dove	11	Pine siskin	9
Common merganser	20	Northern saw-whet owl	11	Porcupine	9
Hooded merganser	20	Whip-poor-will	11	Purple finch	9
Mink	20	Black-billed magpie	10	Red crossbill	9
Northern hawk-owl	20	Broad-winged hawk	10	Ruby-crowned kinglet	9
Cooper's hawk	19	Common nightwawk	10	Ruby-throated hummingbird	9
Wood duck	19	Long-eared owl	10	Swainson's thrush	9
Common raven	18	Sharp-shinned hawk	10	Tree swallow	9
Cope's gray treefrog	18	Alder flycatcher	9	Western kingbird	9
Gray treefrog	18	American redstart	9	White-breasted nuthatch	9
Osprey	18	American tree sparrow	9	White-throated sparrow	9
Wood frog	18	Bay-breasted warbler	9	White-winged crossbill	9
Black-backed woodpecker	17	Black-and-white warbler	9	Wilson's warbler	9
Lynx	17	Black-crowned night heron	9	Winter wren	9
Northern flicker	17	Blackpoll warbler	9	Yellow-bellied flycatcher	9
Ovenbird	17	Black-throated green warbler	9	Yellow warbler	9
Three-toed woodpecker	17	Blackburnian warbler	9	Arctic shrew	8
Wolverine	16	Canada warbler	9	Deer mouse	8
Yellow-bellied sapsucker	16	Cape May warbler	9	Heather vole	8
American crow	15	Chestnut-sided warbler	9	Meadow vole	8
Belted kingfisher	15	Chipping sparrow	9	Northern bog lemming	8
Black-capped chickadee	15	Common redpoll	9	Pygmy shrew	8
Boreal owl	15	Common yellowthroat	9	Southern bog lemming	8
Northern goshawk	15	Connecticut warbler	9	Woodland jumping mouse	8
American kestrel	14	Dark-eyed junco	9		

APPENDIX 6
RANKED VERSATILITY INDEXES FOR 137 SPECIES CONSIDERED FOR MODELING

Common nighthawk	2	Meadow vole	12	Black-and-white warbler	16
Olive-sided flycatcher	4	Mourning warbler	12	Black-capped chickadee	16
Wood duck	5	Nashville warbler	12	Blackpoll warbler	16
Bald eagle	6	Northern goshawk	12	Common redpoll	16
Blue-spotted salamander	6	Northern redbelly snake	12	Dark-eyed junco	16
Canadian toad	6	Northern spring peeper	12	Hermit thrush	16
Common goldeneye	6	Purple finch	12	Northern bog lemming	16
Fox sparrow	6	Red crossbill	12	Northern hawk-owl	16
Orange-crowned warbler	6	Red-breasted nuthatch	12	Palm warbler	16
Osprey	6	White-winged crossbill	12	Red-eyed vireo	16
American robin	7	American toad	13	Southern bog lemming	16
Black-crowned night heron	7	Connecticut warbler	13	Woodland caribou	16
Bufflehead	7	Little brown bat	13	Yellow-bellied flycatcher	16
Common merganser	7	Moose	13	Cedar waxwing	17
Common yellowthroat	7	Northern flicker	13	Great gray owl	17
Hooded merganser	7	Ovenbird	13	Least flycatcher	17
Beaver	8	Solitary vireo	13	Swainson's thrush	17
Canada warbler	8	Winter wren	13	Black-backed woodpecker	18
Chestnut-sided warbler	8	Yellow-bellied sapsucker	13	Blue jay	18
Cope's gray treefrog	8	Bay-breasted warbler	14	Broad-winged hawk	18
Golden-winged warbler	8	Black-throated green warbler	14	Common raven	18
Gray treefrog	8	Blackburnian warbler	14	Cooper's hawk	18
Heather vole	8	Bonaparte's gull	14	Three-toed woodpecker	18
Western kingbird	8	Eastern wood pewee	14	Veery	18
Wilson's warbler	8	Great crested flycatcher	14	Whip-poor-will	18
Yellow warbler	8	Marten	14	Chipping sparrow	19
Black-billed magpie	9	Northern waterthrush	14	Ruby-crowned kinglet	19
Magnolia warbler	9	Pileated woodpecker	14	Boreal owl	20
Tree swallow	9	Pine grosbeak	14	Sharp-shinned hawk	20
Wood frog	9	Western wood pewee	14	Tennessee warbler	20
American tree sparrow	10	White-tailed deer	14	Woodland jumping mouse	20
Barred owl	10	White-throated sparrow	14	Arctic shrew	21
Brown creeper	10	Belted kingfisher	15	Ruffed grouse	21
Indigo bunting	10	Downy woodpecker	15	Deer mouse	22
Lincoln's sparrow	10	Eastern kingbird	15	Porcupine	22
Rose-breasted grosbeak	10	Evening grosbeak	15	Southern red-backed vole	23
Alder flycatcher	11	Gray jay	15	Spruce grouse	23
American kestrel	12	Hairy woodpecker	15	Wolverine	23
American redstart	12	Philadelphia vireo	15	Long-eared owl	24
Boreal chickadee	12	Pine siskin	15	Pygmy shrew	24
Cape May warbler	12	Red squirrel	15	Mourning dove	25
Elk	12	Ruby-throated hummingbird	15	Northern saw-whet owl	25
Golden-crowned kinglet	12	White-breasted nuthatch	15	Black bear	26
Great blue heron	12	Wolf	15	Fisher	27
Lynx	12	American crow	16	Great horned owl	27
				Sharp-tailed grouse	27
				Mink	30